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RESEARCH MEMORANDUM**

EXPLORATORY INVESTIGATION AT MACH NUMBER 4.06 OF AN AIRPLANE
CONFIGURATION HAVING A WING OF TRAPEZOIDAL PLAN FORM

EFFECTS OF VARIOUS TAIL ARRANGEMENTS ON WING-ON
AND WING-OFF STATIC LONGITUDINAL AND
LATERAL STABILITY CHARACTERISTICS

By Robert W. Dunning and Edward F. Ulmann

Langley Aeronautical Laboratory
Langley Field, Va.

CLASSIFIED DOCUMENT

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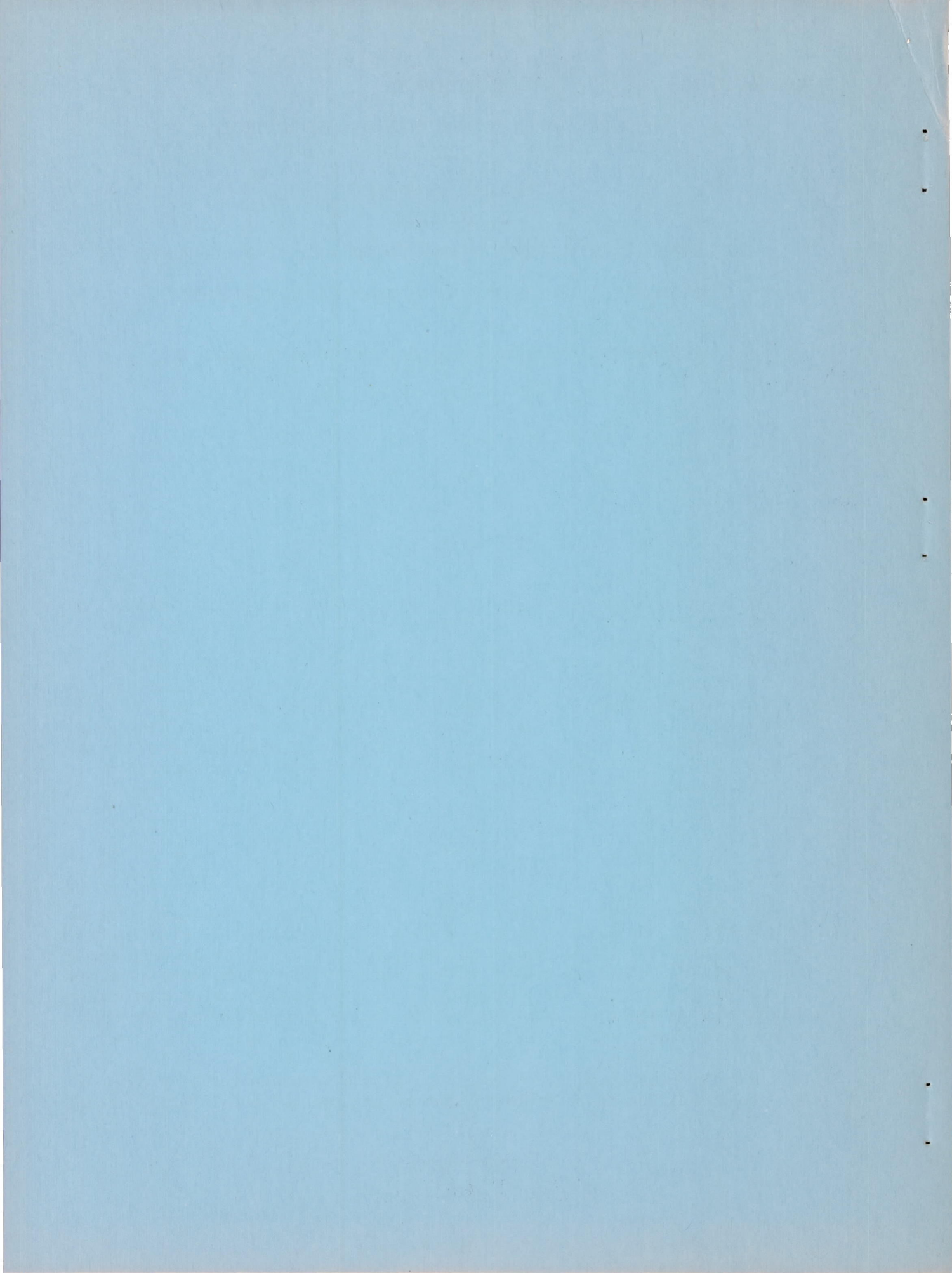
**NATIONAL ADVISORY COMMITTEE
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AND WING-OFF STATIC LONGITUDINAL AND

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SUMMARY

An investigation to determine the longitudinal and lateral stability characteristics of an airplane configuration having a trapezoidal wing with a modified hexagonal airfoil section and a cruciform tail with 5° semiangle wedge section has been carried out in the Langley 9- by 9-inch Mach number 4 blowdown jet. Tests were made with and without the wing for various combinations of the horizontal and vertical tails at a Mach number of 4.06 and a Reynolds number of 2.7×10^6 based on wing mean aerodynamic chord. Data were obtained for angles of attack from 0° up to 12° at angles of sideslip from 0° up to 8° . The data are presented with respect to the body axes.

INTRODUCTION

The airplane configurations previously investigated experimentally at high supersonic and hypersonic speeds have been restricted to missile types which were not required to land and which, therefore, had relatively small wings or wings of very low aspect ratio. The purpose of the present investigation is to determine the characteristics of a configuration conforming more closely to a piloted airplane having a wing area sufficient for conventional landing.

In references 2, 3, and 4 longitudinal and lateral stability data were presented, and in references 5 and 6 longitudinal and lateral control

data were presented for this airplane configuration and various combinations of its components at Mach numbers of 4.06 and 6.86. This report presents, at a Mach number of 4.06, the effects of various combinations of the horizontal and vertical tails on the airplane with and without the wing. The data have been analyzed only to the extent that some stability determinants have been obtained.

SYMBOLS

The results of the tests are presented as standard NACA coefficients of forces and moments. The data are referred to the body axes (fig. 2) with the reference center of gravity at 54 percent wing mean aerodynamic chord (52.66 percent body length from the body nose).

C_N	normal-force coefficient, $-Z_B/qS$
C_Y	lateral-force coefficient, Y/qS
C_m	pitching-moment coefficient about center of gravity, $M'/qS\bar{c}$
C_n	yawing-moment coefficient about center of gravity, N/qSb
C_l	rolling-moment coefficient, L/qSb
Z_B	force along Z_B -axis
Y	force along Y -axis
M'	pitching moment about Y -axis
N	yawing moment about Z_B -axis
L	rolling moment about X_B -axis
q	free-stream dynamic pressure
S	total wing area including body intercept
$\bar{c}$	wing mean aerodynamic chord
b	wing span
R	Reynolds number based on $\bar{c}$

M	Mach number
α	angle of attack of fuselage center line, deg
β	angle of sideslip, deg
$\frac{\partial C_m}{\partial C_N}$	rate of change of pitching-moment coefficient with normal-force coefficient
$C_{Y\beta}$	rate of change of lateral-force coefficient with angle of sideslip
$C_{n\beta}$	rate of change of yawing-moment coefficient with angle of sideslip
$C_{l\beta}$	rate of change of rolling-moment coefficient with angle of sideslip

APPARATUS

The tests were conducted in the Langley 9- by 9-inch Mach number 4 blowdown jet which is described and for which a calibration is given in reference 7. The settling-chamber pressure, which was held constant by a pressure-regulating valve, and the corresponding air temperature were continuously recorded during each run. A sting-mounted internal strain-gage balance which measured normal force, pitching moment, side force, yawing moment, and rolling moment was used to obtain the data.

MODELS

The model configurations used for the present investigation consist of various combinations of the horizontal and vertical tails in conjunction with the body and body-wing combination. Details concerning the geometric characteristics of the complete airplane and wing and tail sections are given in table I and figures 3 and 4. The model designations used throughout the report are graphically illustrated in figure 5. The wing has a trapezoidal plan form with a hexagonal section that has been modified by rounding the leading edge to a 1-percent-chord radius and blunting the trailing edge to a 2-percent-chord thickness. The wing has a maximum thickness of 4 percent, and the quarter-chord line is swept 29°. The tails have a trapezoidal plan form, a 5° semiangle wedge section, and a 0.007-inch leading-edge radius. A photograph of the complete airplane configuration installed in the Langley 9- by 9-inch Mach number 4 blowdown jet is presented in figure 6.

TESTS

The settling-chamber stagnation temperature during any single run varied from approximately 80°F to 40°F , and the settling-chamber stagnation pressure was held at approximately 186 pounds per square inch absolute. These conditions correspond approximately to a Reynolds number of 2.7×10^6 based on the wing mean aerodynamic chord. The tests were run at humidities below 5×10^{-6} pounds of water vapor per pound of dry air, which is believed to be low enough to eliminate water-condensation effects. The test-section static temperature and pressure did not reach the point where liquefaction of air would take place. Data were obtained for angles of attack from 0° up to 12° at angles of sideslip from 0° up to 8° .

PRECISION OF DATA

The probable uncertainties in the test data due to the accuracy limitations of the balance and recording equipment and the ability of the system to repeat data points are listed in the following table: (The accuracy of the rolling-moment coefficients is low relative to the maximum rolling moment encountered. This low accuracy occurred because rolling-moment gages were added to an existing balance which was not originally designed to measure rolling moment.)

C_N		± 0.001
C_Y		± 0.0003
C_m		± 0.0004
C_n		± 0.00005
C_l		± 0.0009
α , deg		± 0.1
β , deg		± 0.1

RESULTS

The experimental static aerodynamic characteristics of the configurations are given in table II for all the angles of attack and sideslip tested, and representative parts of the data are presented in the figures. Equations for transferring these coefficients from the body axes to the stability axes are

$$C_{Y_S} = C_{Y_B} \quad (1)$$

$$C_{L_S} = C_{L_B} \cos \alpha + C_{n_B} \sin \alpha \quad (2)$$

$$C_{n_S} = C_{n_B} \cos \alpha - C_{L_B} \sin \alpha \quad (3)$$

$$C_{m_S} = C_{m_B} \quad (4)$$

Inasmuch as longitudinal forces were not measured, the axes transfer equations for lift and drag coefficients are not given.

The static longitudinal characteristics of the model are presented in figures 7 and 8. Figure 9 presents the longitudinal stability derivative $\partial C_m / \partial C_N$ for several tail configurations.

The effects of sideslip angle on the lateral and longitudinal characteristics of the models are presented in figures 10 to 13. Figure 14 presents the static lateral stability parameters C_{n_β} , C_{l_β} , and C_{Y_β} for several tail configurations. Variations of the lateral characteristics with angle of attack are presented in figures 15 to 17, and figure 18 presents the variation of the static lateral characteristics with normal-force coefficient for several tail configurations.

Langley Aeronautical Laboratory,
National Advisory Committee for Aeronautics,
Langley Field, Va., March 21, 1955.

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2. Dunning, Robert W., and Ulmann, Edward F.: Static Longitudinal and Lateral Stability Data From an Exploratory Investigation at Mach Number 4.06 of an Airplane Configuration Having a Wing of Trapezoidal Plan Form. NACA RM L55A21, 1955.
3. Penland, Jim A., Ridyard, Herbert W., and Fetterman, David E., Jr.: Lift, Drag, and Static Longitudinal Stability Data From an Exploratory Investigation at a Mach Number of 6.86 of an Airplane Configuration Having a Wing of Trapezoidal Plan Form. NACA RM L54L03b, 1955.
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TABLE I.- GEOMETRIC CHARACTERISTICS OF MODEL

Wing:

Area (including area submerged in fuselage), sq in.	6.24
Span, in.	4.33
Mean aerodynamic chord, in.	1.716
Root chord, in.	2.53
Tip chord, in.	0.354
Airfoil section	Hexagonal with round leading edge
Taper ratio	0.140
Aspect ratio	3.00
Sweep of leading edge, deg	38.83
Sweep of c/4 line, deg	29
Incidence at fuselage center line, deg	0
Dihedral, deg	0
Geometric twist, deg	0

Horizontal and vertical tails:

Area (including area submerged in fuselage), sq in.	2.06
Span, in.	2.69
Mean aerodynamic chord, in.	0.853
Root chord, in.	1.214
Tip chord, in.	0.317
Airfoil section	5° semiangle wedge
Taper ratio	0.261
Aspect ratio	3.52
Sweep of leading edge, deg	22.63
Dihedral, deg	0

Fuselage:

Length, in.	7.50
Maximum diameter, in.	0.790
Fineness ratio	9.50
Base diameter, in.	0.790
Distance from nose to moment reference	3.950
Ogive nose length, in.	2.29
Ogive radius, in.	6.85

TABLE II.- STATIC LONGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$]

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(a) Body						
See table II(b), reference 2.						
(b) Body with upper vertical tail						
0 ↓ Y	0 1 2 3 4 6 8	-0.0045 -.0043 -.0042 -.0041 -.0040 -.0044 -.0047	0.0056 .0058 .0059 .0061 .0068 .0082 .0094	-0.0009 -.0089 -.0172 -.0250 -.0338 -.0521 -.0752	0.0001 .0004 .0007 .0010 .0016 .0026 .0050	0.0015 .0004 .0001 -.0005 -.0012 -.0028 -.0043
2 ↓ Y	0 1 2 3 4 6 8	.0040 .0036 .0042 .0043 .0050 .0068 .0071	.0145 .0141 .0141 .0140 .0143 .0147 .0146	-.0007 -.0089 -.0171 -.0248 -.0339 -.0520 -.0747	.0001 .0003 .0007 .0010 .0015 .0026 .0047	.0013 .0008 .0001 -.0006 -.0015 -.0027 -.0042
4 ↓ Y	0 1 2 3 4 6 8	.0146 .0146 .0158 .0164 .0171 .0201 .0218	.0230 .0228 .0227 .0225 .0218 .0208 .0199	-.0007 -.0088 -.0172 -.0257 -.0342 -.0532 -.0755	.0001 .0003 .0007 .0011 .0015 .0027 .0043	.0012 .0005 -.0001 -.0006 -.0014 -.0026 -.0039

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AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(b) Body with upper vertical tail - Concluded						
6 ↓ ↓	0	0.0265	0.0297	-0.0008	0.0000	0.0015
	1	.0271	.0297	-.0092	.0003	.0011
	2	.0277	.0295	-.0179	.0006	.0004
	3	.0284	.0292	-.0268	.0011	.0000
	4	.0314	.0270	-.0361	.0016	-.0015
	6	.0344	.0253	-.0552	.0025	-.0028
	8	.0372	.0243	-.0759	.0036	-.0040
8 ↓ ↓	0	.0457	.0305	.0000	.0000	.0007
	1	.0452	.0305	-.0083	.0002	.0004
	2	.0458	.0307	-.0181	.0003	.0000
	3	.0469	.0306	-.0268	.0007	-.0005
	4	.0475	.0300	-.0363	.0010	-.0009
	6	.0496	.0297	-.0575	.0021	-.0016
	8	.0537	.0282	-.0767	.0026	-.0037
10 ↓ ↓	0	.0648	.0327	-.0002	.0000	.0009
	1	.0650	.0333	-.0084	-.0002	.0006
	2	.0646	.0335	-.0169	-.0004	.0000
	3	.0654	.0331	-.0262	-.0003	-.0006
	4	.0662	.0329	-.0357	-.0001	-.0012
	6	.0683	.0322	-.0558	.0010	-.0024
12 ↓ ↓	0	.0841	.0357	.0006	.0001	.0002
	1	.0840	.0359	-.0075	-.0004	-.0002
	2	.0851	.0362	-.0163	-.0010	-.0004
	3	.0845	.0357	-.0257	-.0011	-.0010
	4	.0862	.0352	-.0355	-.0009	-.0013
	6	.0885	.0347	-.0566	.0000	-.0023

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AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(c) Body with lower vertical tail						
0 ↓ Y	0	0.0008	-0.0062	-0.0009	-0.0002	0.0016
	1	.0018	-.0061	-.0090	.0001	.0022
	2	.0017	-.0067	-.0171	.0005	.0027
	3	.0027	-.0071	-.0255	.0008	.0028
	4	.0032	-.0074	-.0340	.0014	.0031
	6	.0037	-.0082	-.0516	.0026	.0035
	8	.0047	-.0091	-.0741	.0047	.0040
	8	.0047	-.0091	-.0741	.0047	.0040
2 ↓ Y	0	.0087	.0025	-.0011	-.0002	.0016
	1	.0097	.0023	-.0089	.0002	.0021
	2	.0107	.0021	-.0172	.0006	.0027
	3	.0112	.0010	-.0252	.0010	.0026
	4	.0117	.0001	-.0343	.0015	.0032
	6	.0144	-.0014	-.0522	.0028	.0037
	8	.0170	-.0036	-.0753	.0052	.0041
	8	.0170	-.0036	-.0753	.0052	.0041
4 ↓ Y	0	.0187	.0129	-.0006	-.0002	.0019
	1	.0203	.0126	-.0091	.0002	.0021
	2	.0208	.0123	-.0175	.0008	.0024
	3	.0224	.0097	-.0260	.0012	.0027
	4	.0239	.0084	-.0353	.0018	.0028
	6	.0271	.0050	-.0547	.0034	.0035
	8	.0305	.0021	-.0766	.0057	.0042
	8	.0305	.0021	-.0766	.0057	.0042
6 ↓ Y	0	.0320	.0170	-.0008	-.0002	.0016
	1	.0330	.0169	-.0089	.0003	.0020
	2	.0351	.0163	-.0183	.0010	.0026
	3	.0361	.0150	-.0278	.0016	.0028
	4	.0378	.0133	-.0377	.0024	.0029
	6	.0425	.0123	-.0586	.0043	.0037
	8	.0456	.0066	-.0794	.0063	.0041
	8	.0456	.0066	-.0794	.0063	.0041

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[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(c) Body with lower vertical tail - Concluded						
8 ↓ Y	0	0.0505	0.0192	-.0006	-0.0003	0.0014
	1	.0505	.0189	-.0093	.0006	.0019
	2	.0515	.0184	-.0195	.0014	.0024
	3	.0536	.0173	-.0302	.0023	.0026
	4	.0558	.0166	-.0402	.0032	.0028
	6	.0590	.0141	-.0618	.0051	.0036
	8	.0616	.0133	-.0824	.0071	.0041
10	0	.0717	.0218	.0002	-0.0003	.0015
(d) Body with vertical tails						
0 ↓ Y	0	-.0024	-.0003	-.0010	-.0001	.0016
	1	-.0019	-.0006	-.0124	.0025	.0019
	2	-.0019	-.0008	-.0239	.0049	.0020
	3	-.0007	-.0004	-.0341	.0071	.0012
	4	-.0007	-.0005	-.0453	.0094	.0009
	6	-.0011	.0000	-.0682	.0143	.0002
	6	-.0011	.0000	-.0682	.0143	.0002
2 ↓ Y	0	.0055	.0078	-.0008	.0000	.0018
	1	.0071	.0083	-.0116	.0025	.0018
	2	.0071	.0078	-.0234	.0049	.0019
	3	.0077	.0077	-.0340	.0070	.0012
	4	.0089	.0074	-.0452	.0094	.0009
	6	.0101	.0064	-.0695	.0143	.0004
	6	.0101	.0064	-.0695	.0143	.0004
4 ↓ Y	0	.0166	.0169	-.0009	.0000	.0015
	1	.0166	.0165	-.0114	.0022	.0018
	2	.0187	.0162	-.0234	.0047	.0016
	3	.0193	.0158	-.0345	.0068	.0013
	4	.0199	.0140	-.0457	.0093	.0011
	6	.0225	.0125	-.0704	.0143	.0005
	6	.0225	.0125	-.0704	.0143	.0005

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[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(d) Body with vertical tails - Concluded						
6 ↓ ↓ ↓ ↓ ↓ ↓	0	0.0292	0.0221	-0.0007	-0.0001	0.0016
	1	.0302	.0220	-.0122	.0022	.0020
	2	.0325	.0218	-.0235	.0045	.0014
	3	.0331	.0209	-.0349	.0068	.0010
	4	.0348	.0198	-.0476	.0094	.0007
	6	.0378	.0171	-.0724	.0141	.0003
8 ↓ ↓ ↓ ↓ ↓ ↓	0	.0476	.0239	-.0002	-.0002	.0016
	1	.0481	.0240	-.0112	.0019	.0019
	2	.0493	.0240	-.0235	.0043	.0014
	3	.0504	.0234	-.0360	.0066	.0015
	4	.0518	.0230	-.0476	.0088	.0007
	6	.0554	.0209	-.0740	.0138	.0005
(e) Body with horizontal tail						
0 ↓ ↓ ↓ ↓ ↓ ↓	0	-.0024	.0003	-.0008	-.0003	.0018
	1	-.0013	-.0001	-.0055	-.0020	.0018
	2	-.0013	-.0002	-.0103	-.0038	.0017
	3	-.0007	-.0001	-.0150	-.0053	.0009
	4	-.0007	-.0001	-.0206	-.0067	.0011
	6	-.0001	.0000	-.0327	-.0087	.0006
	8	-.0010	-.0002	-.0530	-.0096	-.0001
2 ↓ ↓ ↓ ↓ ↓ ↓	0	.0172	-.0111	-.0005	-.0002	.0018
	1	.0188	-.0115	-.0056	-.0019	.0018
	2	.0193	-.0115	-.0105	-.0037	.0015
	3	.0195	-.0110	-.0153	-.0051	.0011
	4	.0200	-.0111	-.0211	-.0065	.0011
	6	.0204	-.0107	-.0337	-.0086	.0005
	8	.0218	-.0112	-.0531	-.0095	-.0003

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AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(e) Body with horizontal tail - Concluded						
4 ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	0.0426	-0.0253	-0.0005	-0.0002	0.0016
	1	.0431	-.0255	-.0054	-.0017	.0021
	2	.0431	-.0252	-.0110	-.0033	.0016
	3	.0433	-.0248	-.0162	-.0046	.0010
	4	.0436	-.0247	-.0224	-.0059	.0007
	6	.0450	-.0242	-.0360	-.0077	.0006
	8	.0470	-.0234	-.0553	-.0090	-.0006
6 ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	.0675	-.0383	-.0001	.0000	.0017
	1	.0685	-.0386	-.0062	-.0014	.0019
	2	.0691	-.0380	-.0123	-.0027	.0014
	3	.0687	-.0376	-.0190	-.0039	.0011
	4	.0697	-.0370	-.0252	-.0049	.0004
	6	.0704	-.0363	-.0396	-.0067	.0002
	8	.0728	-.0370	-.0581	-.0082	-.0008
8 ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	.0955	-.0532	.0000	.0000	.0018
	1	.0961	-.0534	-.0067	-.0010	.0017
	2	.0967	-.0524	-.0142	-.0021	.0012
	3	.0957	-.0515	-.0209	-.0030	.0008
	4	.0971	-.0512	-.0278	-.0038	.0002
	6	.0982	-.0512	-.0432	-.0057	-.0003
	8	.0996	-.0491	-.0614	-.0074	-.0015

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AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(f) Body with horizontal and upper vertical tails						
0 ↓ ↓	0	-0.0043	0.0067	-0.0010	0.0000	0.0007
	1	-.0037	.0063	-.0090	.0004	.0001
	2	-.0036	.0062	-.0175	.0008	-.0004
	3	-.0035	.0068	-.0255	.0012	-.0013
	4	-.0034	.0071	-.0344	.0019	-.0020
	6	-.0031	.0078	-.0523	.0033	-.0037
	8	-.0034	.0086	-.0745	.0057	-.0049
2 ↓ ↓	0	.0158	-.0043	-.0009	.0000	.0005
	1	.0163	-.0045	-.0089	.0004	.0003
	2	.0175	-.0049	-.0173	.0008	-.0004
	3	.0177	-.0048	-.0251	.0012	-.0013
	4	.0178	-.0039	-.0342	.0018	-.0022
	6	.0181	-.0036	-.0524	.0031	-.0035
	8	.0184	-.0024	-.0751	.0054	-.0052
4 ↓ ↓	0	.0411	-.0187	-.0005	.0000	.0005
	1	.0412	-.0188	-.0091	.0004	.0002
	2	.0419	-.0186	-.0174	.0010	-.0007
	3	.0420	-.0182	-.0261	.0014	-.0014
	4	.0422	-.0176	-.0349	.0019	-.0023
	6	.0440	-.0174	-.0536	.0032	-.0036
	8	.0436	-.0154	-.0754	.0051	-.0051
6 ↓ ↓	0	.0654	-.0322	-.0002	.0000	.0004
	1	.0654	-.0324	-.0089	.0005	.0001
	2	.0667	-.0321	-.0180	.0011	-.0008
	3	.0674	-.0319	-.0275	.0016	-.0015
	4	.0686	-.0315	-.0367	.0022	-.0022
	6	.0691	-.0307	-.0561	.0034	-.0038
	8	.0693	-.0289	-.0764	.0048	-.0053

TABLE II.- STATIC LONGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(f) Body with horizontal and upper vertical tails - Concluded						
8 ↓ Y	0	0.0944	-0.0476	0.0004	-0.0001	0.0005
	1	.0945	-.0477	-.0094	.0004	.0002
	2	.0948	-.0465	-.0183	.0009	-.0009
	3	.0949	-.0460	-.0277	.0015	-.0015
	4	.0958	-.0459	-.0371	.0019	-.0025
	6	.0971	-.0446	-.0574	.0033	-.0036
	8	.0959	-.0413	-.0768	.0044	-.0055
(g) Body with horizontal and lower vertical tails						
0 ↓ Y	0	-.0008	-.0049	-.0012	-.0002	.0015
	1	.0007	-.0050	-.0088	.0002	.0024
	2	.0012	-.0050	-.0172	.0006	.0027
	3	.0012	-.0062	-.0251	.0010	.0026
	4	.0027	-.0072	-.0340	.0015	.0031
	6	.0031	-.0081	-.0518	.0030	.0036
	8	.0036	-.0088	-.0742	.0054	.0042
2 ↓ Y	0	.0204	-.0177	-.0008	-.0002	.0013
	1	.0203	-.0176	-.0089	.0002	.0022
	2	.0218	-.0177	-.0176	.0007	.0026
	3	.0229	-.0184	-.0253	.0012	.0026
	4	.0239	-.0187	-.0342	.0018	.0031
	6	.0250	-.0197	-.0528	.0032	.0036
	8	.0265	-.0201	-.0752	.0057	.0040

TABLE II.- STATIC LONGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(g) Body with horizontal and lower vertical tails - Concluded						
4 ↓	0	0.0452	-0.0305	-0.0005	-0.0002	0.0013
	1	.0451	-.0306	-.0091	.0003	.0022
	2	.0462	-.0311	-.0178	.0010	.0023
	3	.0478	-.0318	-.0263	.0016	.0027
	4	.0483	-.0318	-.0351	.0023	.0030
	6	.0500	-.0329	-.0552	.0040	.0032
	8	.0514	-.0330	-.0774	.0066	.0039
6 ↓	0	.0700	-.0456	-.0004	-.0002	.0012
	1	.0699	-.0457	-.0091	.0006	.0019
	2	.0716	-.0459	-.0186	.0015	.0022
	3	.0721	-.0460	-.0286	.0024	.0024
	4	.0727	-.0462	-.0385	.0033	.0027
	6	.0760	-.0466	-.0585	.0052	.0033
	8	.0771	-.0467	-.0801	.0076	.0037
8 ↓	0	.0985	-.0602	.0004	-.0002	.0013
	1	.0985	-.0601	-.0102	.0009	.0017
	2	.0997	-.0599	-.0210	.0021	.0022
(h) Body with cruciform tail						
See table II(d), reference 2.						
(i) Body-wing combination						
See table II(c), reference 2.						

TABLE II.- STATIC LONGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(j) Body-wing combination with upper vertical tail						
0 ↓	0	-0.0028	0.0056	-0.0003	-0.0001	0.0010
	1	-.0043	.0053	-.0075	.0002	.0003
	2	-.0042	.0054	-.0161	.0005	-.0002
	3	-.0031	.0059	-.0240	.0008	-.0013
	4	-.0066	.0052	-.0334	.0013	-.0018
	5	-.0054	.0062	-.0424	.0019	-.0025
	6	-.0059	.0069	-.0526	.0026	-.0029
	7	-.0069	.0074	-.0636	.0036	-.0038
	8	-.0057	.0078	-.0743	.0046	-.0044
2 ↓	0	.0351	.0098	.0001	-.0001	.0010
	1	.0370	.0102	-.0070	.0000	.0000
	2	.0345	.0102	-.0154	.0001	-.0006
	3	.0322	.0104	-.0227	.0003	-.0013
	4	.0335	.0105	-.0318	.0005	-.0017
	5	.0358	.0115	-.0403	.0009	-.0023
	6	.0344	.0115	-.0507	.0015	-.0031
	7	.0353	.0123	-.0607	.0023	-.0038
	8	.0372	.0124	-.0722	.0032	-.0042
4 ↓	0	.0794	.0148	.0007	-.0001	.0008
	1	.0794	.0151	-.0061	-.0003	.0001
	2	.0776	.0153	-.0142	-.0003	-.0006
	3	.0799	.0161	-.0218	-.0003	-.0014
	4	.0783	.0160	-.0306	-.0004	-.0020
	5	.0787	.0166	-.0393	-.0002	-.0027
	6	.0789	.0167	-.0494	.0003	-.0032
	7	.0799	.0171	-.0594	.0009	-.0038
	8	.0801	.0169	-.0705	.0018	-.0043

TABLE II.- STATIC LONGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(j) Body-wing combination with upper vertical tail - Concluded						
6 ↓	0	0.1231	0.0187	0.0016	-0.0001	0.0003
	1	.1250	.0191	-.0056	-.0005	-.0007
	2	.1238	.0196	-.0133	-.0008	-.0011
	3	.1236	.0205	-.0212	-.0010	-.0016
	4	.1221	.0202	-.0300	-.0012	-.0021
	5	.1218	.0206	-.0390	-.0011	-.0026
	6	.1250	.0212	-.0487	-.0008	-.0030
	7	.1242	.0213	-.0588	-.0002	-.0036
	8	.1256	.0218	-.0700	.0005	-.0044
8 ↓	0	.1712	.0213	.0024	-.0001	.0005
	1	.1704	.0218	-.0052	-.0005	-.0002
	2	.1716	.0226	-.0124	-.0011	-.0009
	3	.1707	.0235	-.0205	-.0016	-.0018
	4	.1735	.0239	-.0298	-.0019	-.0023
	5	.1736	.0269	-.0386	-.0020	-.0026
	6	.1722	.0264	-.0489	-.0018	-.0033
	7	.1726	.0269	-.0597	-.0013	-.0040
	8	.1725	.0276	-.0707	-.0008	-.0046
10 ↓	0	.2256	.0231	.0034	-.0001	.0004
	1	.2266	.0237	-.0057	-.0005	-.0007
	2	.2229	.0245	-.0114	-.0014	-.0012
	3	.2257	.0257	-.0213	-.0021	-.0020
	4	.2243	.0275	-.0306	-.0025	-.0027
	5	.2243	.0279	-.0394	-.0025	-.0032
	6	.2254	.0290	-.0497	-.0026	-.0041
	7	.2247	.0298	-.0611	-.0023	-.0047
12 ↓	0	.2843	.0235	.0040	.0000	.0002
	1	.2845	.0239	-.0050	-.0006	-.0006

TABLE II.- STATIC LONGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(k) Body-wing combination with lower vertical tail						
0 ↓ ↓ ↓ ↓ ↓ ↓	0	0.0019	-0.0064	-0.0002	-0.0004	0.0013
	1	.0045	-.0061	-.0079	.0005	.0014
	2	.0044	-.0065	-.0161	.0009	.0021
	3	.0047	-.0075	-.0237	.0007	.0019
	4	.0017	-.0086	-.0329	.0010	.0026
	6	.0037	-.0089	-.0513	.0023	.0032
	8	.0036	-.0104	-.0737	.0041	.0040
2 ↓ ↓ ↓ ↓ ↓ ↓	0	.0420	-.0015	.0005	-.0003	.0010
	1	.0416	-.0017	-.0076	.0000	.0015
	2	.0436	-.0016	-.0163	.0012	.0019
	3	.0411	-.0022	-.0244	.0014	.0019
	4	.0417	-.0026	-.0336	.0018	.0023
	6	.0434	-.0035	-.0540	.0032	.0030
	8	.0456	-.0053	-.0748	.0052	.0040
4 ↓ ↓ ↓ ↓ ↓ ↓	0	.0852	.0034	.0008	-.0002	.0012
	1	.0866	.0035	-.0070	.0005	.0013
	2	.0861	.0034	-.0164	.0015	.0020
	3	.0865	.0035	-.0249	.0019	.0018
	4	.0844	.0027	-.0350	.0025	.0019
	6	.0883	.0012	-.0559	.0043	.0032
	8	.0910	-.0012	-.0788	.0068	.0039
6 ↓ ↓ ↓ ↓ ↓ ↓	0	.1312	.0074	.0016	-.0002	.0006
	1	.1316	.0074	-.0070	.0007	.0013
	2	.1317	.0074	-.0169	.0017	.0017
	3	.1303	.0074	-.0262	.0024	.0015
	4	.1297	.0065	-.0370	.0033	.0020
	6	.1312	.0049	-.0584	.0052	.0027
	8	.1342	.0029	-.0811	.0079	.0038

TABLE II.- STATIC LOGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(k) Body-wing combination with lower vertical tail - Concluded						
8 ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	0.1812	0.0108	0.0023	-0.0002	0.0007
	1	.1791	.0103	-.0070	.0008	.0006
	2	.1770	.0103	-.0178	.0025	.0016
	3	.1788	.0100	-.0274	.0029	.0011
	4	.1780	.0100	-.0389	.0040	.0014
	6	.1785	.0094	-.0614	.0064	.0026
	8	.1833	.0071	-.0869	.0095	.0034
10 ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	.2324	.0117	.0037	-.0002	.0006
	1	.2318	.0120	-.0081	.0012	.0013
	2	.2328	.0120	-.0186	.0025	.0015
	3	.2339	.0121	-.0303	.0038	.0016
	4	.2318	.0119	-.0427	.0055	.0013
	6	.2309	.0116	-.0665	.0082	.0021
12 ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	.2876	.0120	.0047	-.0002	.0005
	1	.2876	.0121	-.0084	.0016	.0010
	2	.2859	.0124	-.0204	.0034	.0007
	3	.2875	.0131	-.0339	.0051	.0013
	4	.2861	.0129	-.0468	.0072	.0013
	6	.2874	.0139	-.0730	.0107	.0021

TABLE II.- STATIC LOGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(1) Body-wing combination with vertical tails						
0 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	0.0000	-0.0002	-0.0003	-0.0004	0.0002
	0	.0000	-.0001	-.0001	-.0004	.0002
	1	.0015	-.0002	-.0111	.0021	.0004
	1	-.0006	-.0002	-.0113	.0020	.0002
	2	.0005	-.0004	-.0226	.0045	.0000
	2	-.0006	-.0004	-.0223	.0044	.0001
	3	-.0004	-.0005	-.0335	.0069	-.0008
	3	-.0011	-.0005	-.0339	.0068	.0002
	4	-.0027	-.0009	-.0460	.0094	.0001
	4	-.0011	-.0007	-.0456	.0094	.0001
	5	-.0011	-.0006	-.0573	.0117	.0001
2 ↓ ↓ ↓ ↓ ↓	0	.0374	.0039	.0003	-.0003	-.0001
	1	.0375	.0040	-.0105	.0021	-.0002
	2	.0398	.0042	-.0218	.0046	-.0003
	3	.0378	.0039	-.0329	.0070	-.0008
	4	.0384	.0040	-.0456	.0094	.0003
	5	.0380	.0039	-.0569	.0116	.0001
4 ↓ ↓ ↓ ↓ ↓	0	.0848	.0090	.0011	-.0003	-.0001
	1	.0830	.0089	-.0104	.0021	-.0001
	2	.0832	.0090	-.0212	.0046	-.0002
	3	.0828	.0091	-.0328	.0070	-.0007
	4	.0831	.0090	-.0453	.0094	.0002
	5	.0844	.0087	-.0572	.0117	.0004
6 ↓ ↓ ↓ ↓ ↓	0	.1259	.0145	.0019	-.0002	-.0004
	1	.1296	.0139	-.0095	.0022	-.0006
	2	.1272	.0138	-.0211	.0047	-.0003
	3	.1269	.0139	-.0325	.0069	-.0006
	4	.1265	.0136	-.0455	.0094	.0002
	5	.1277	.0129	-.0581	.0117	.0004

TABLE II.- STATIC LOGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(l) Body-wing combination with vertical tails - Concluded						
8 ↓ ↓ ↓ ↓ ↓	0	0.1790	0.0148	0.0028	-0.0002	-0.0004
	1	.1782	.0149	-.0084	.0023	-.0007
	2	.1756	.0151	-.0216	.0047	-.0011
	3	.1750	.0152	-.0333	.0069	-.0013
	4	.1786	.0153	-.0473	.0094	.0006
	5	.1766	.0151	-.0602	.0118	-.0001
10 ↓ ↓ ↓ ↓ ↓	0	.2267	.0156	.0037	-.0002	-.0004
	1	.2311	.0159	-.0098	.0026	-.0006
	2	.2315	.0167	-.0223	.0050	-.0007
	3	.2310	.0171	-.0345	.0071	-.0004
	4	.2287	.0174	-.0491	.0098	.0002
	5	.2287	.0175	-.0625	.0125	.0003
12 ↓ ↓ ↓	0	.2858	.0155	.0048	-.0003	-.0005
	1	.2862	.0159	-.0096	.0028	-.0006
	2	.2867	.0164	-.0229	.0053	-.0009
	3	.2871	.0171	-.0369	.0078	-.0007
(m) Body-wing combination with horizontal tail						
0 ↓ ↓ ↓ ↓ ↓ ↓ ↓	0	-.0034	.0010	-.0004	-.0003	.0014
	1	-.0012	.0006	-.0049	-.0019	.0009
	2	-.0017	.0008	-.0096	-.0036	.0010
	3	-.0050	.0018	-.0144	-.0053	.0004
	4	-.0032	.0011	-.0206	-.0071	.0003
	6	-.0021	.0010	-.0338	-.0094	.0000
	8	-.0021	.0014	-.0514	-.0104	.0001

TABLE II.- STATIC LOGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(m) Body-wing combination with horizontal tail - Concluded						
2 ↓ ↓ ↓ ↓ ↓ ↓	0	0.0483	-0.0115	0.0004	-0.0002	0.0010
	1	.0522	-.0121	-.0040	-.0019	.0008
	2	.0481	-.0111	-.0090	-.0038	.0005
	3	.0475	-.0111	-.0138	-.0053	.0001
	4	.0495	-.0113	-.0199	-.0071	-.0002
	6	.0507	-.0110	-.0331	-.0095	-.0004
	8	.0514	-.0103	-.0511	-.0106	-.0005
4 ↓ ↓ ↓ ↓ ↓ ↓	0	.1035	-.0241	.0013	-.0003	.0009
	1	.1028	-.0241	-.0035	-.0021	.0005
	2	.1043	-.0241	-.0082	-.0039	.0003
	3	.1010	-.0233	-.0137	-.0056	-.0003
	4	.1034	-.0236	-.0196	-.0072	-.0006
	6	.1036	-.0221	-.0336	-.0096	-.0008
	8	.1061	-.0212	-.0514	-.0107	-.0014
6 ↓ ↓ ↓ ↓ ↓ ↓	0	.1562	-.0356	.0022	-.0003	.0005
	1	.1565	-.0355	-.0026	-.0022	.0000
	2	.1545	-.0345	-.0078	-.0041	-.0004
	3	.1548	-.0338	-.0130	-.0059	-.0008
	4	.1582	-.0341	-.0203	-.0074	-.0008
	6	.1564	-.0315	-.0348	-.0096	-.0012
	8	.1588	-.0306	-.0521	-.0108	-.0021
8 ↓	0	.2128	-.0479	.0035	-.0003	.0004
	1	.2145	-.0475	-.0023	-.0022	.0002
(n) Body-wing combination with horizontal and upper vertical tails						
See table II(b), reference 5.						

TABLE II.- STATIC LOGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

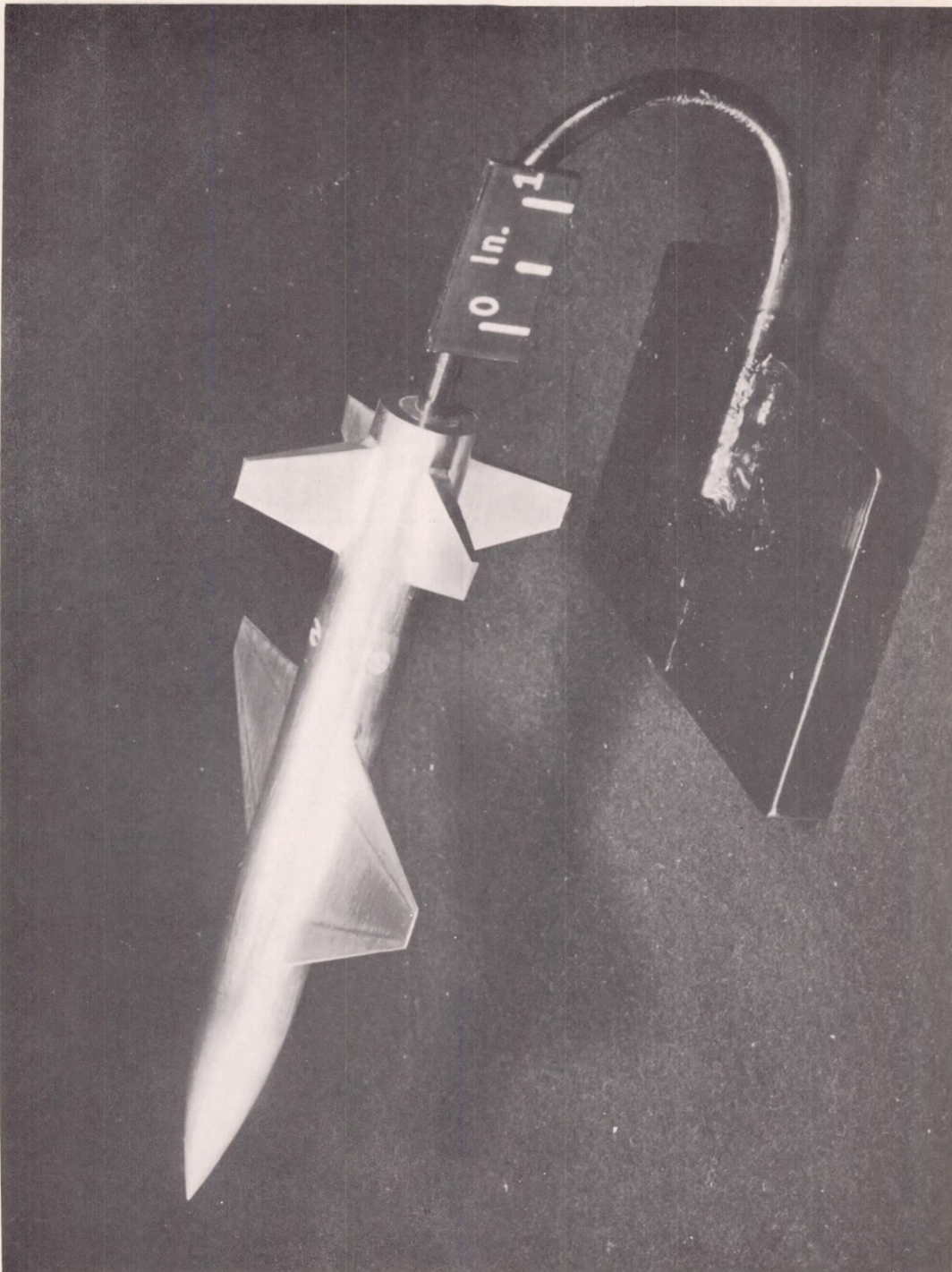
[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Continued

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(o) Body-wing combination with horizontal and lower vertical tails						
See table II(c), reference 5.						
(p) Body-wing combination with cruciform tail						
See table II(a), reference 2.						
(q) Body-wing combination with X-tail						
0 ↓ Y	0	-0.0001	-0.0006	-0.0011	0.0000	0.0005
	0	.0004	-.0001	-.0006	-.0001	.0006
	1	-.0006	-.0004	-.0116	.0022	.0006
	1	.0004	-.0002	-.0116	.0021	.0007
	2	.0005	-.0004	-.0226	.0043	.0004
	2	.0009	-.0003	-.0224	.0042	.0012
	3	.0000	-.0001	-.0319	.0059	-.0001
	3	.0009	-.0004	-.0326	.0061	.0011
	4	-.0006	-.0002	-.0431	.0080	.0001
	4	-.0012	-.0002	-.0440	.0082	.0009
	5	-.0016	.0008	-.0545	.0102	-.0006
	5	-.0017	-.0001	-.0561	.0104	.0006
Y ↓ Y	6	-.0033	.0001	-.0685	.0126	.0011
	6	-.0017	.0000	-.0682	.0126	.0010
	2	.0404	-.0076	-.0001	.0000	.0005
	1	.0411	-.0078	-.0111	.0022	.0000
	2	.0412	-.0077	-.0221	.0043	-.0001
	3	.0414	-.0078	-.0319	.0061	-.0004
Y ↓ Y	4	.0411	-.0075	-.0430	.0082	-.0008
	5	.0401	-.0066	-.0543	.0104	-.0008
	6	.0408	-.0078	-.0690	.0129	.0011

TABLE II.- STATIC LOGITUDINAL AND LATERAL AERODYNAMIC CHARACTERISTICS OF
AN AIRPLANE CONFIGURATION AND VARIOUS COMBINATIONS OF ITS COMPONENTS

[BODY-AXIS DATA; $M = 4.06$; $R = 2.7 \times 10^6$] - Concluded

α , deg	β , deg	C_N	C_m	C_Y	C_n	C_l
(q) Body-wing combination with X-tail - Concluded						
4 ↓ Y	0	0.0951	-0.0176	0.0008	-0.0001	0.0004
	1	.0979	-.0178	-.0108	.0023	.0002
	2	.0962	-.0174	-.0217	.0045	-.0003
	3	.0948	-.0168	-.0322	.0064	-.0003
	4	.0957	-.0164	-.0430	.0086	-.0006
	5	.0960	-.0158	-.0549	.0109	-.0008
	6	.0973	-.0176	-.0705	.0136	.0011
6 ↓ Y	0	.1458	-.0264	.0021	-.0002	.0003
	1	.1459	-.0265	-.0102	.0023	.0001
	2	.1449	-.0268	-.0218	.0045	-.0002
	3	.1450	-.0270	-.0333	.0067	-.0004
	4	.1445	-.0250	-.0460	.0091	-.0009
	5	.1452	-.0246	-.0575	.0115	-.0011
	6	.1476	-.0271	-.0726	.0138	.0007



L-86688

Figure 1.- Complete-model configuration.

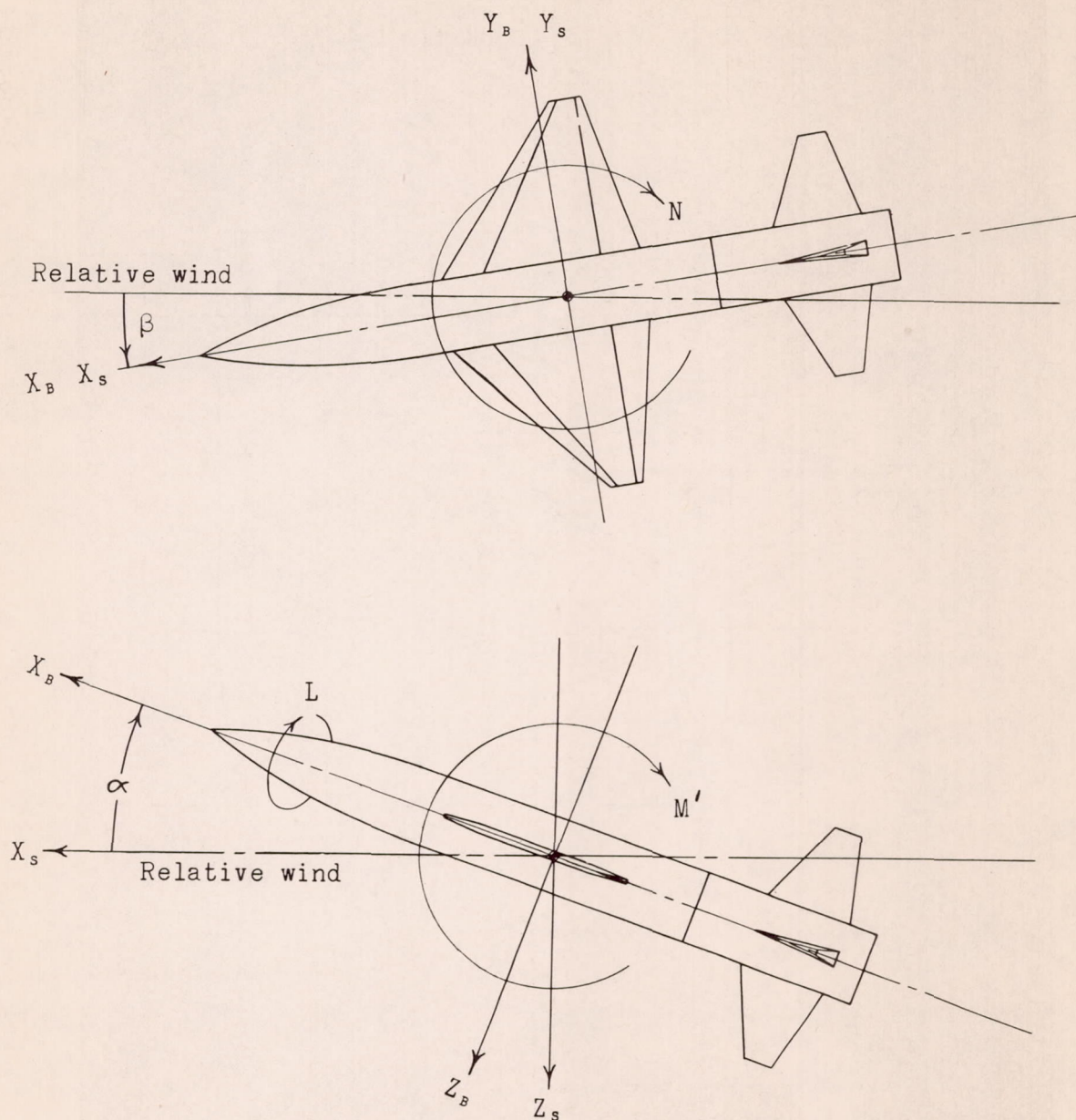


Figure 2.- Systems of reference axes. Subscript B indicates body axes; subscript S indicates stability axes.

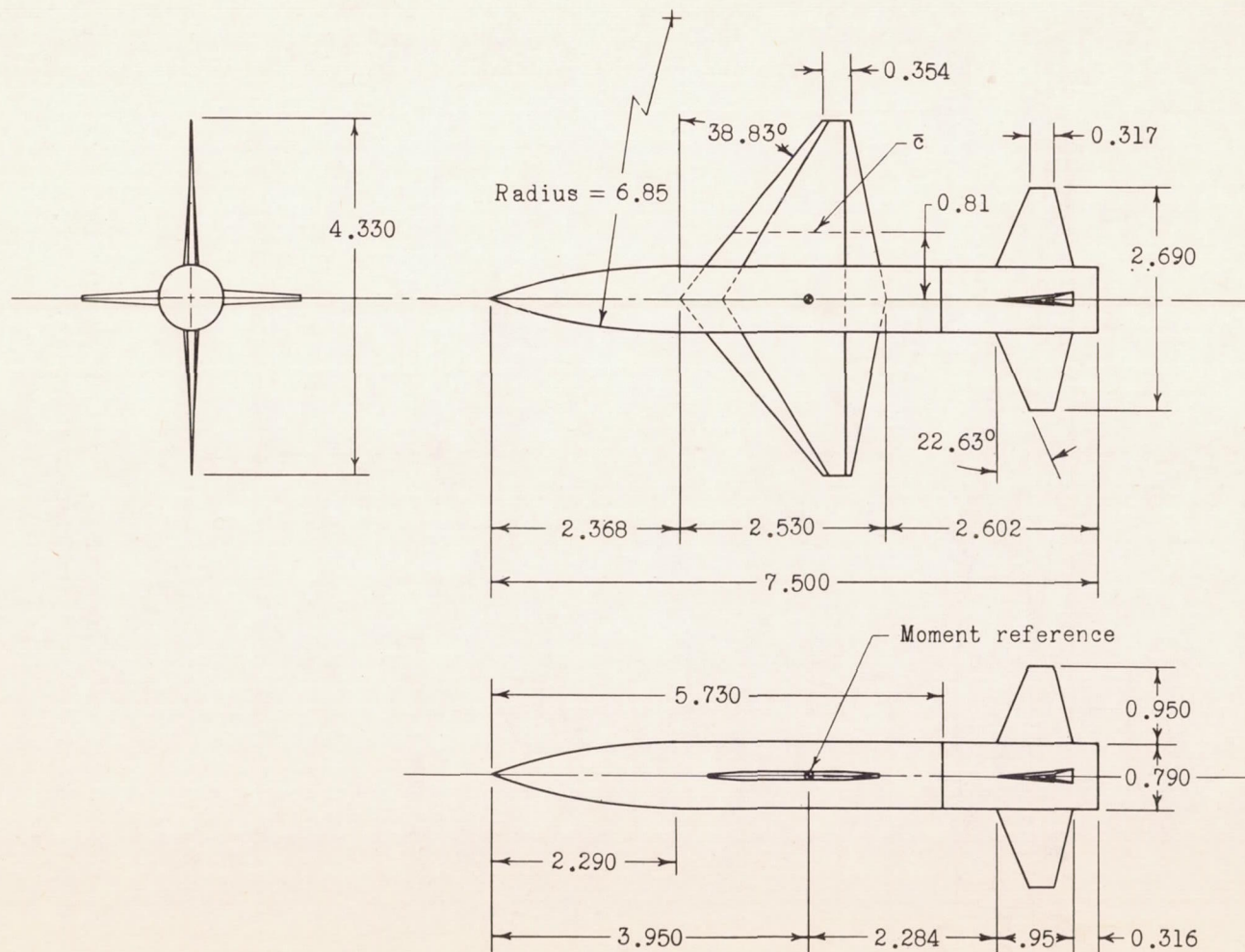
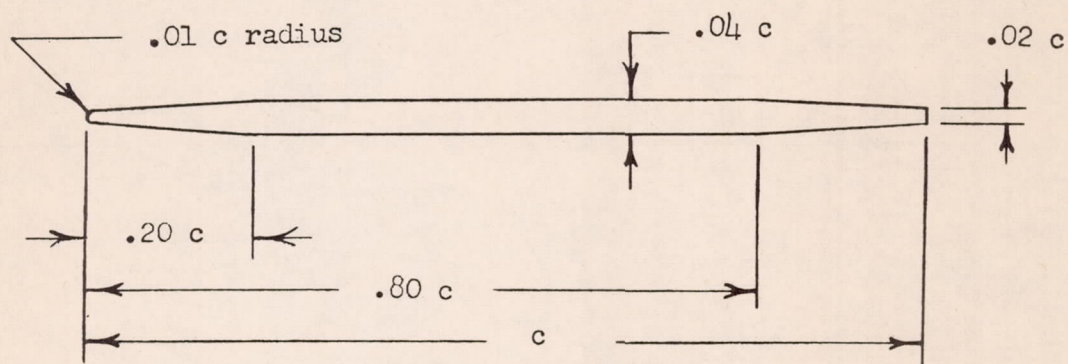
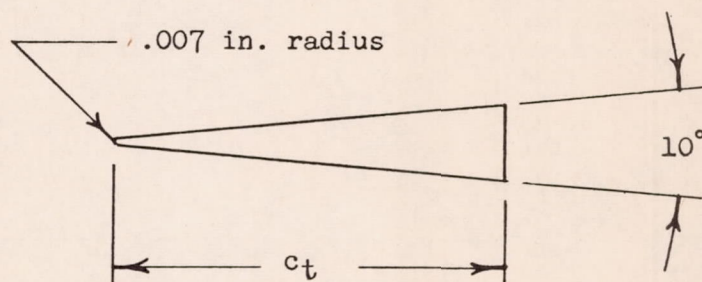


Figure 3.- Wind-tunnel model. All dimensions are in inches.



(a) Wing.



(b) Horizontal and vertical tails.

Figure 4.- Wing and tail airfoil sections used on model.

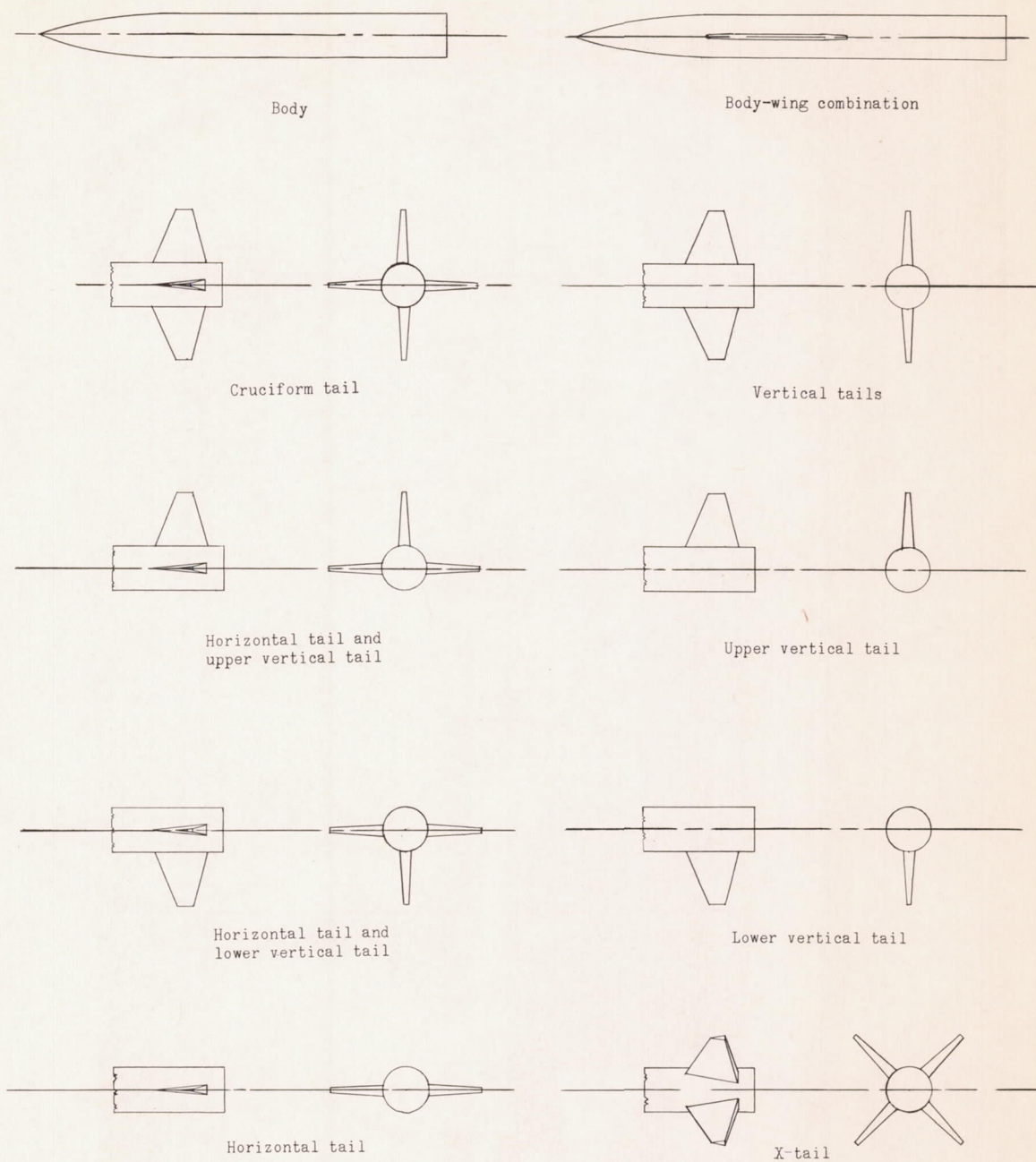


Figure 5.- Model designations.

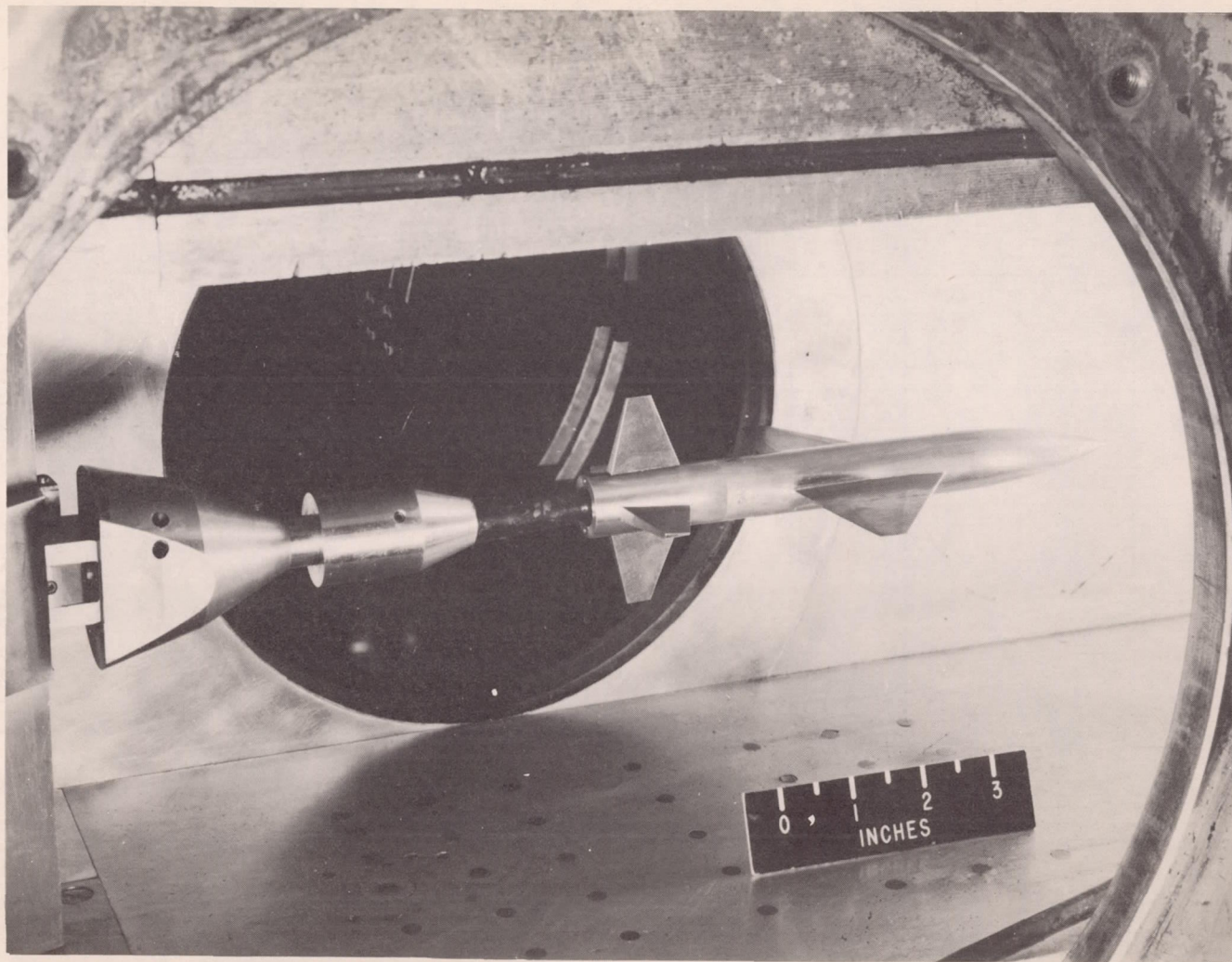
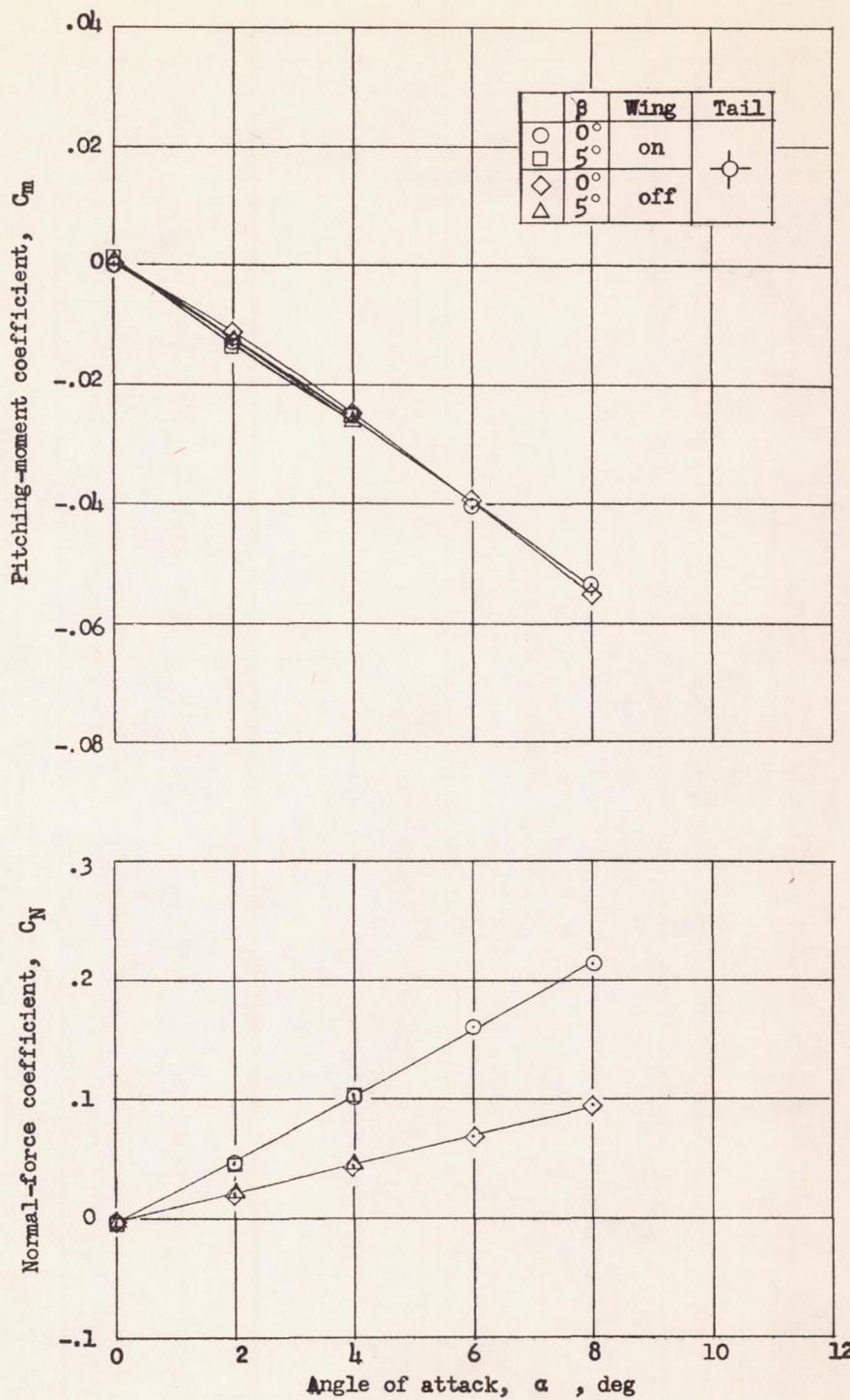


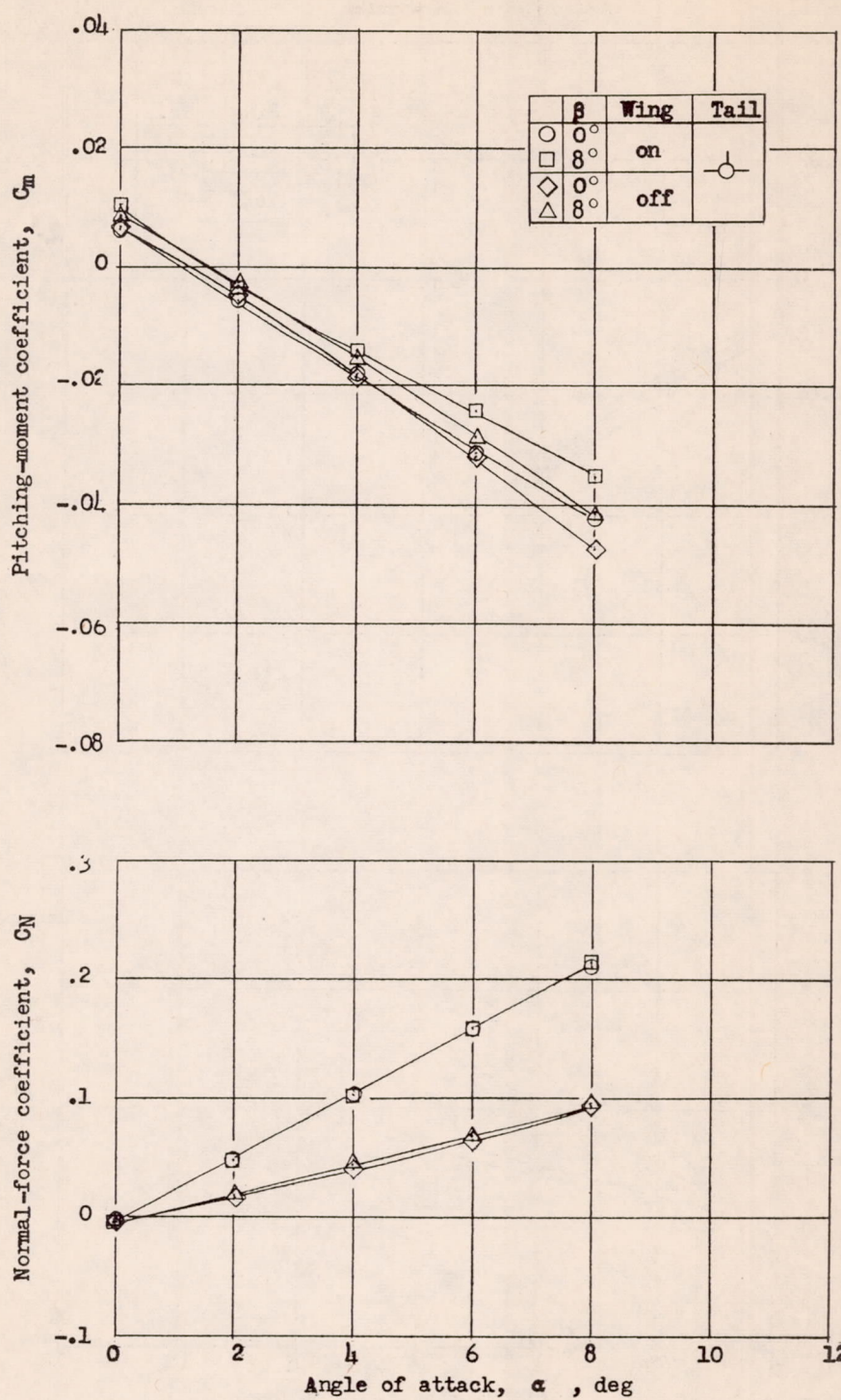
Figure 6.- Installation of wind-tunnel model in Langley 9- by 9-inch
Mach number 4 blowdown jet.

L-87425



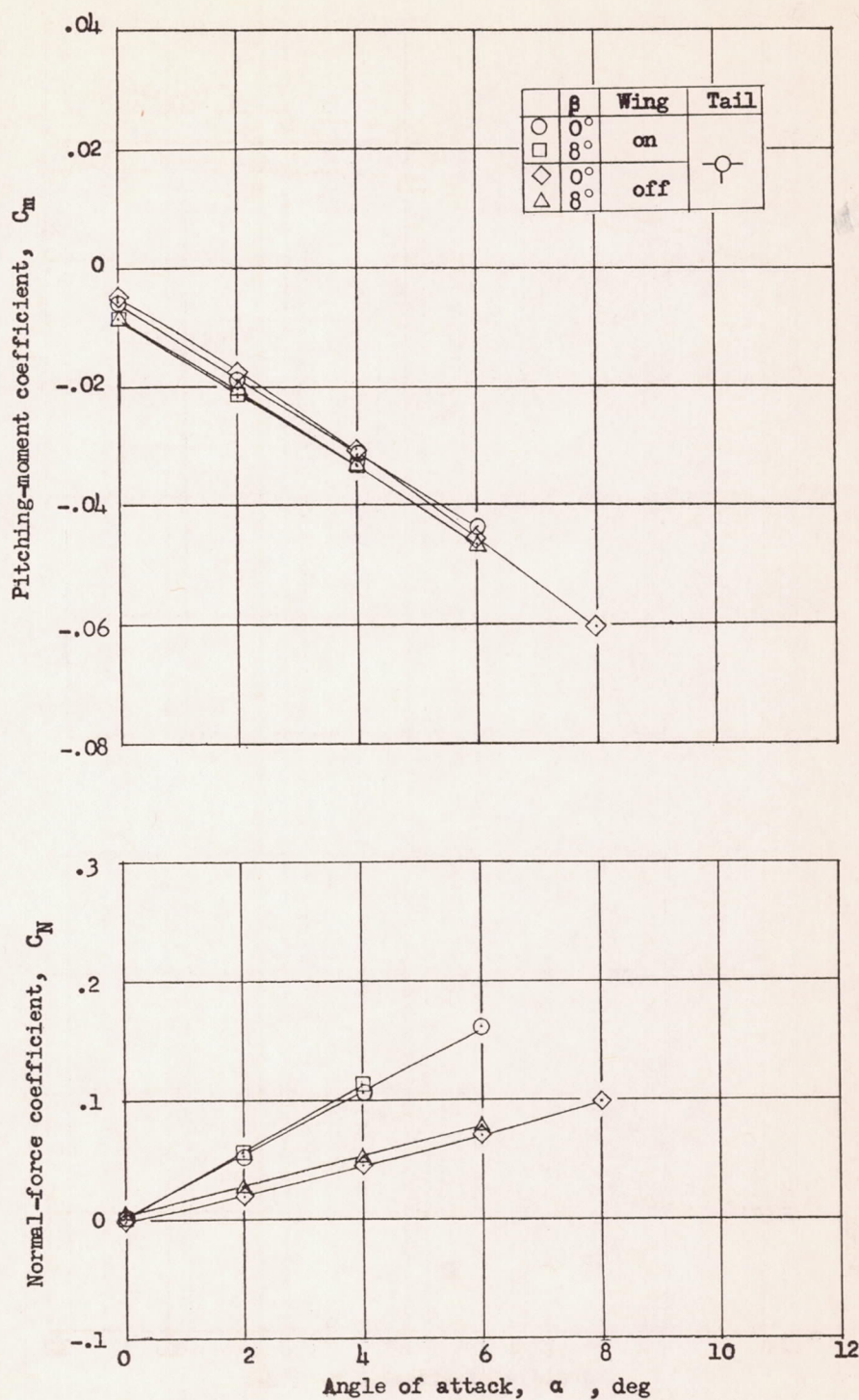
(a) Cruciform tail.

Figure 7.- Effect of the wing on the variation of static longitudinal characteristics of an airplane configuration with various tail arrangements.



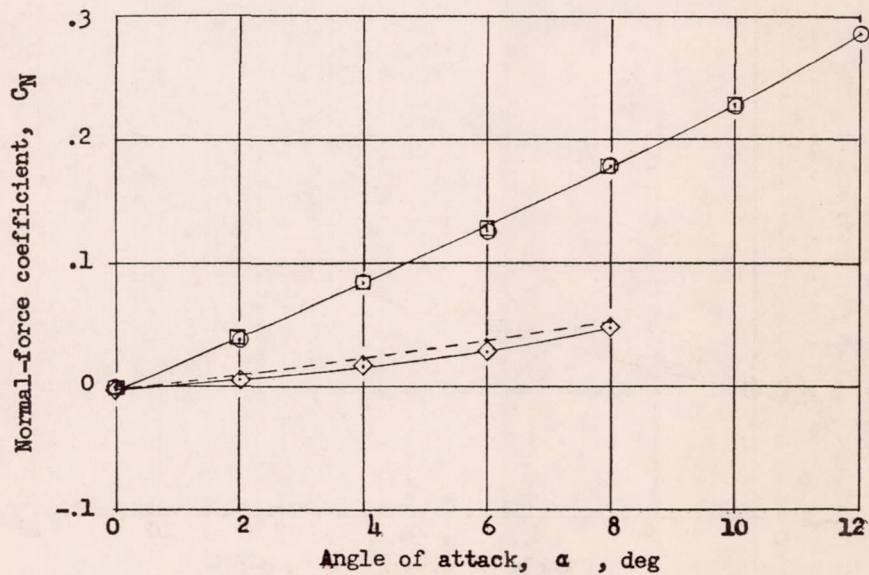
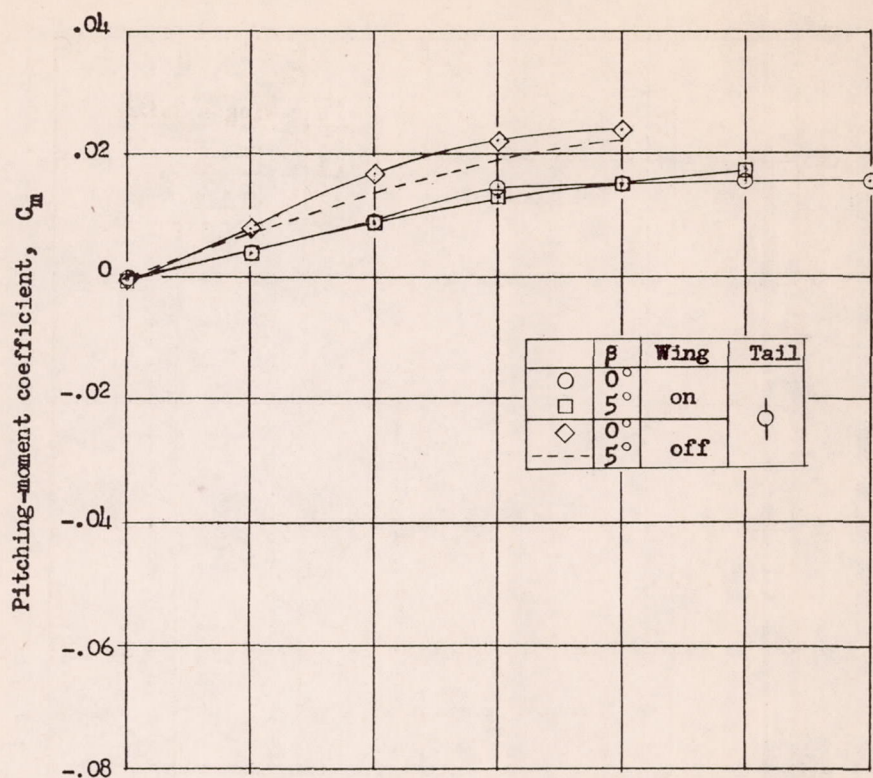
(b) Horizontal tail and upper vertical tail.

Figure 7.- Continued.



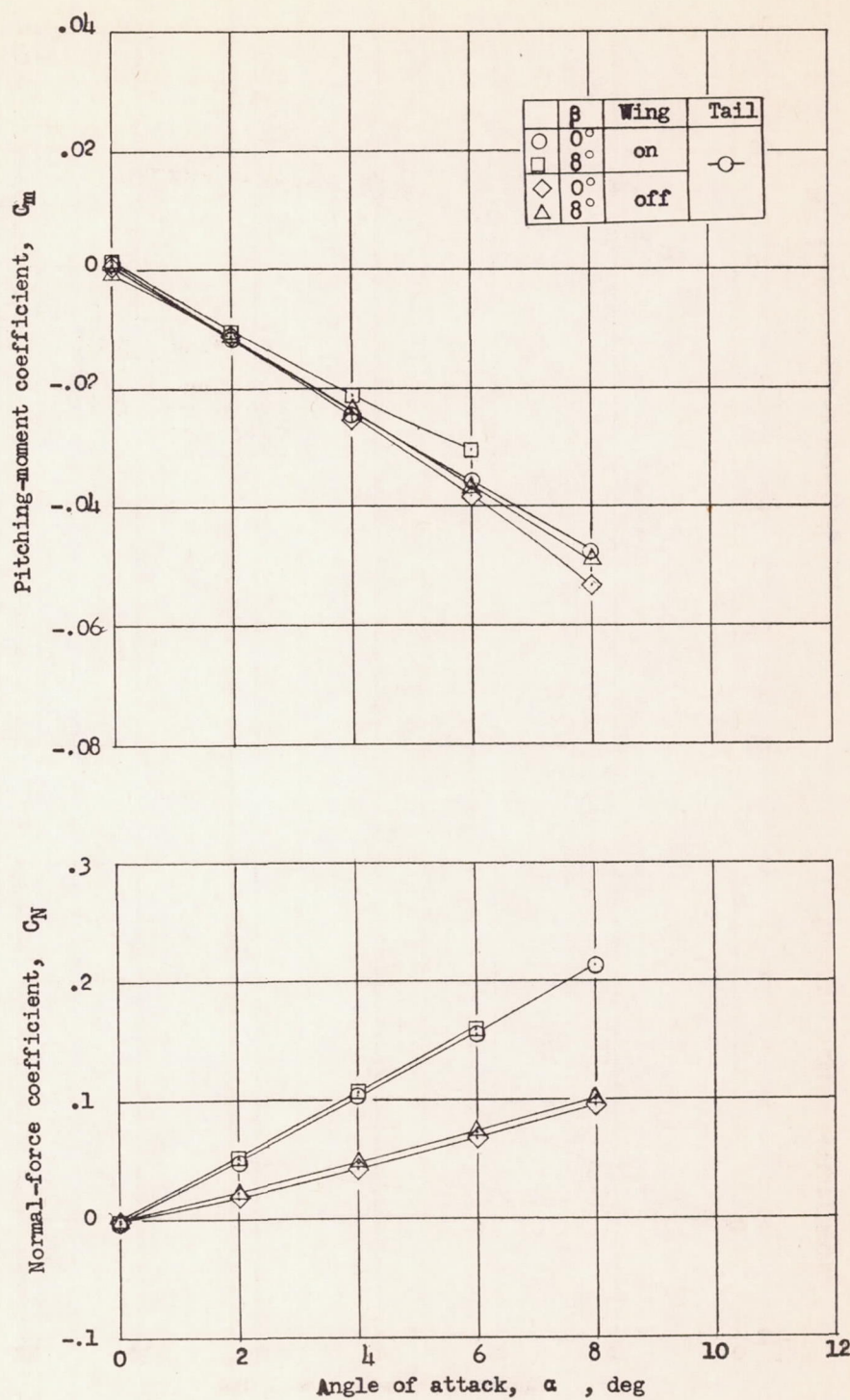
(c) Horizontal tail and lower vertical tail.

Figure 7.- Continued.



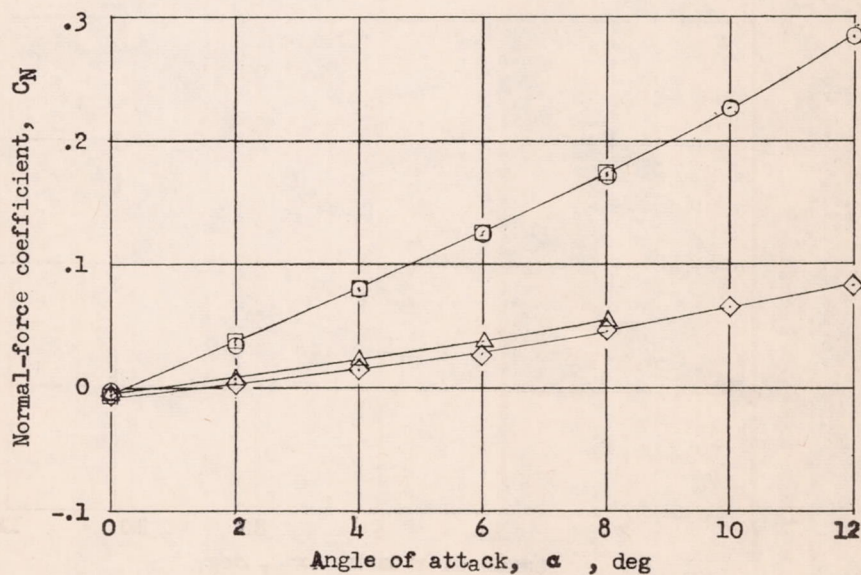
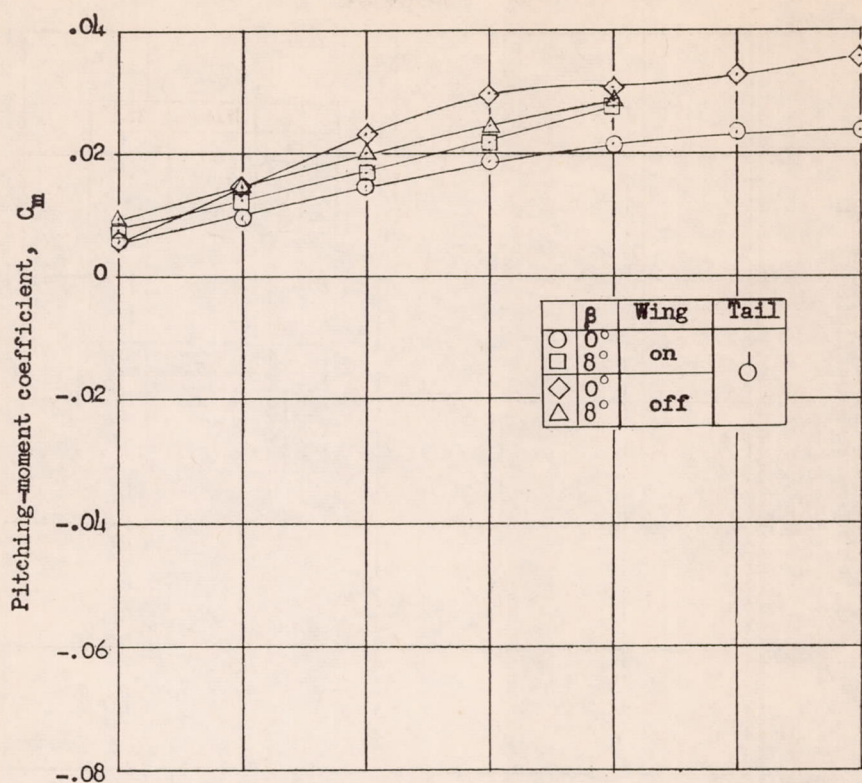
(d) Vertical tails.

Figure 7.- Continued.



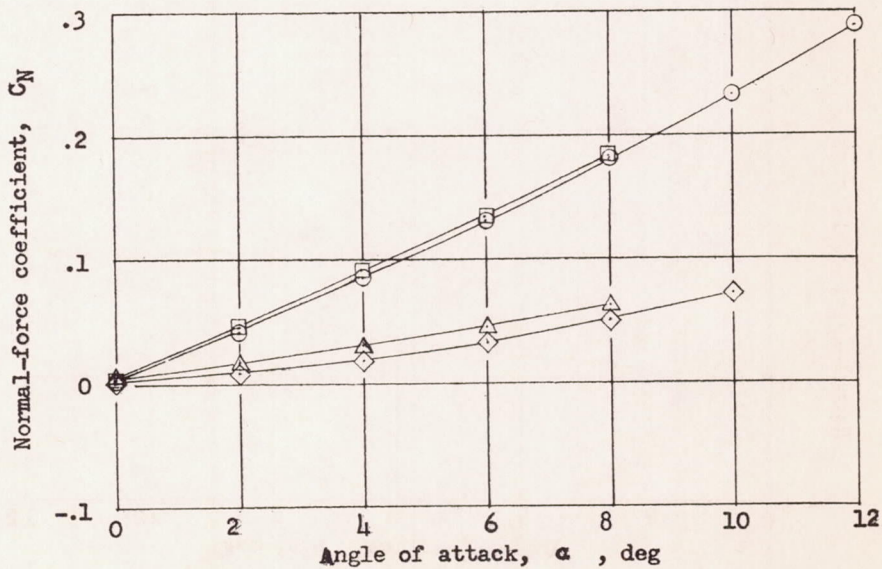
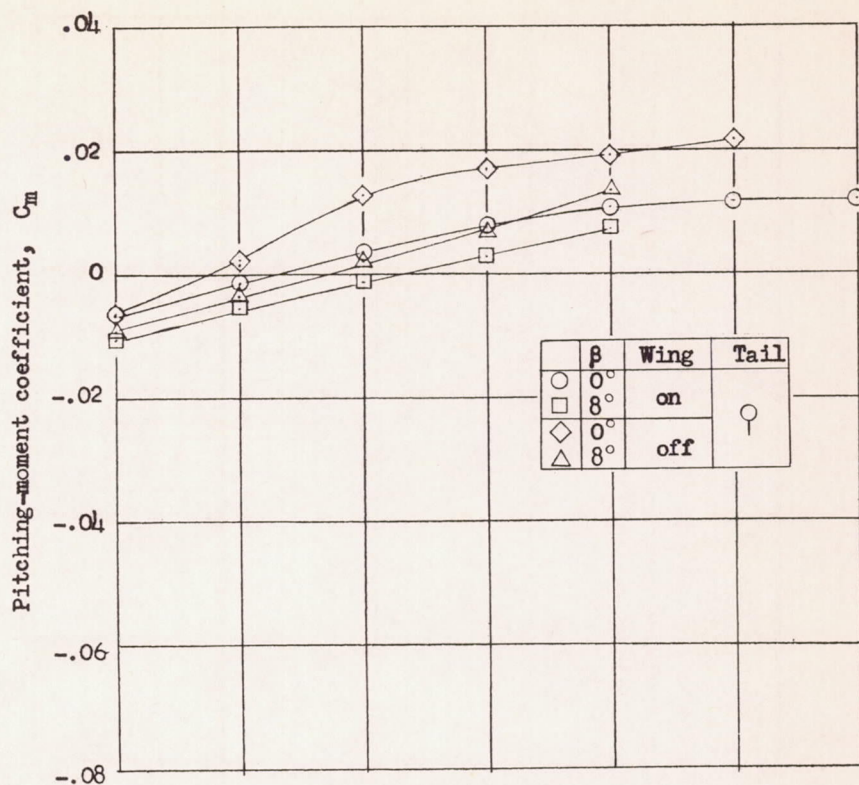
(e) Horizontal tail.

Figure 7.- Continued.



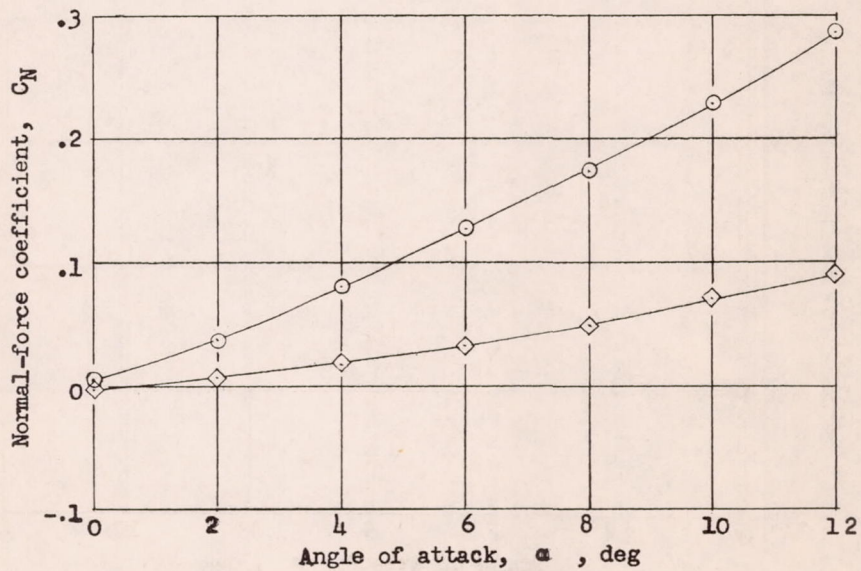
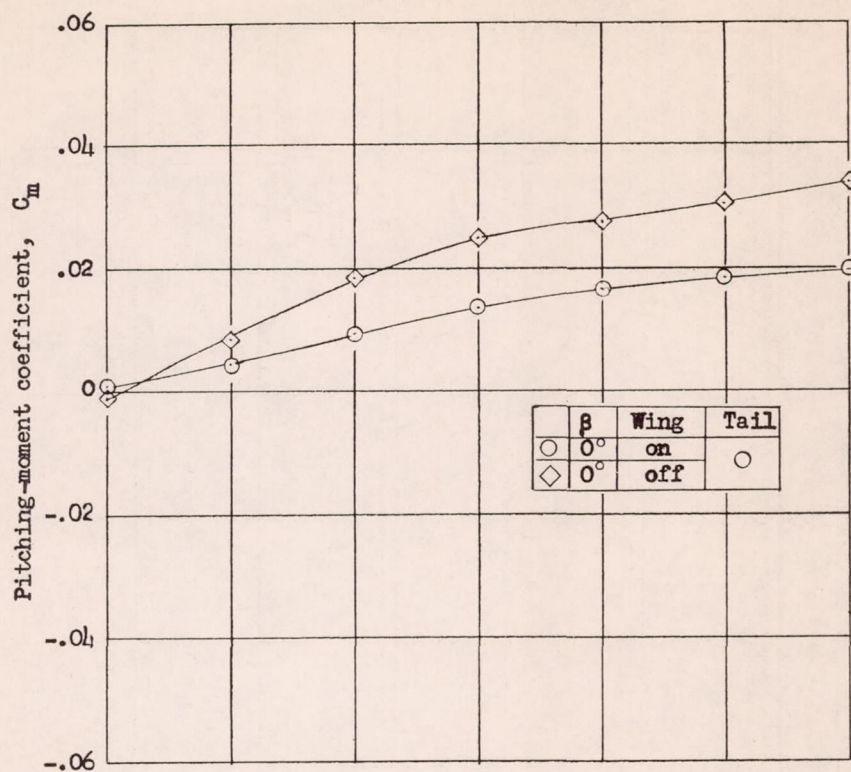
(f) Upper vertical tail.

Figure 7.- Continued.



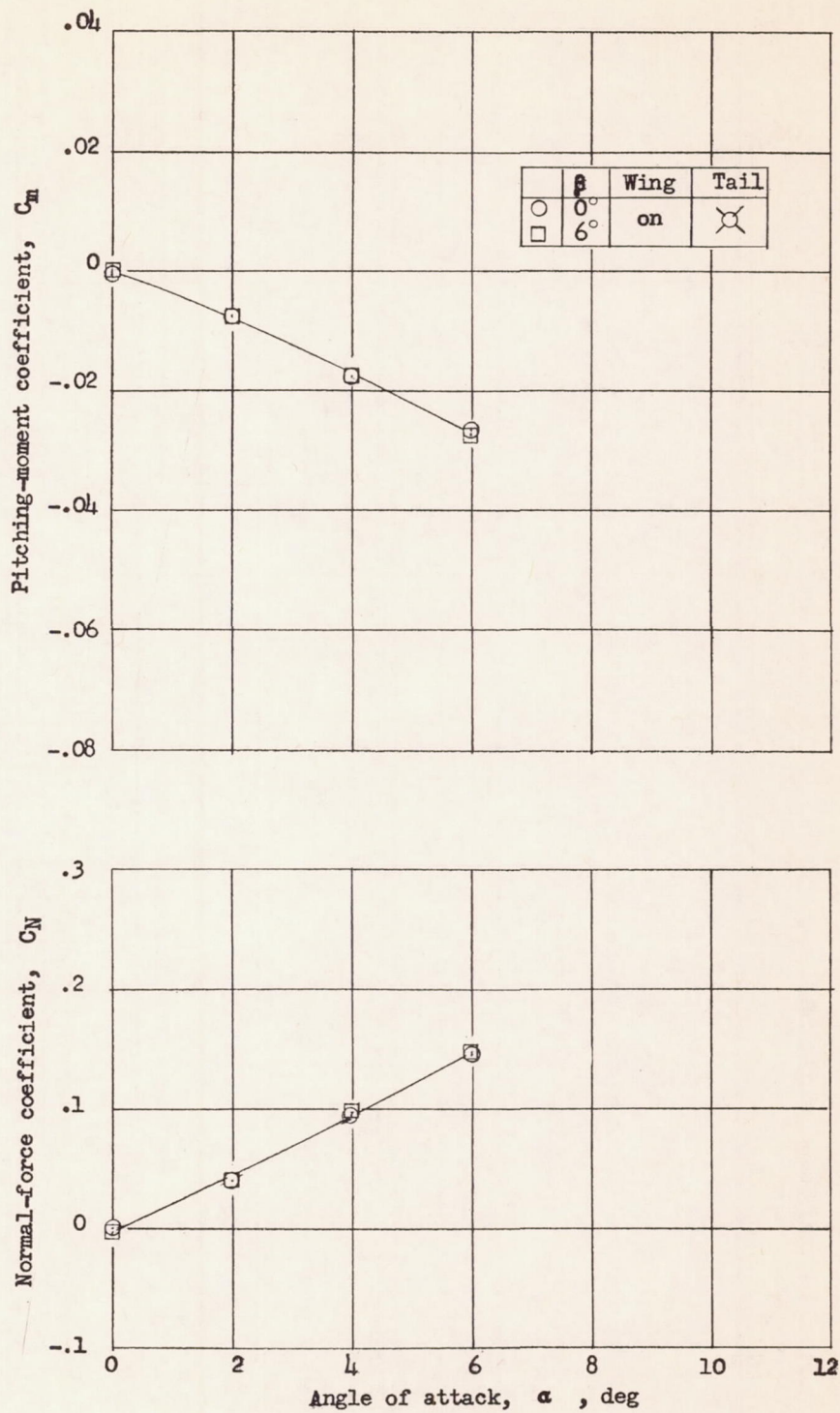
(g) Lower vertical tail.

Figure 7.- Continued.



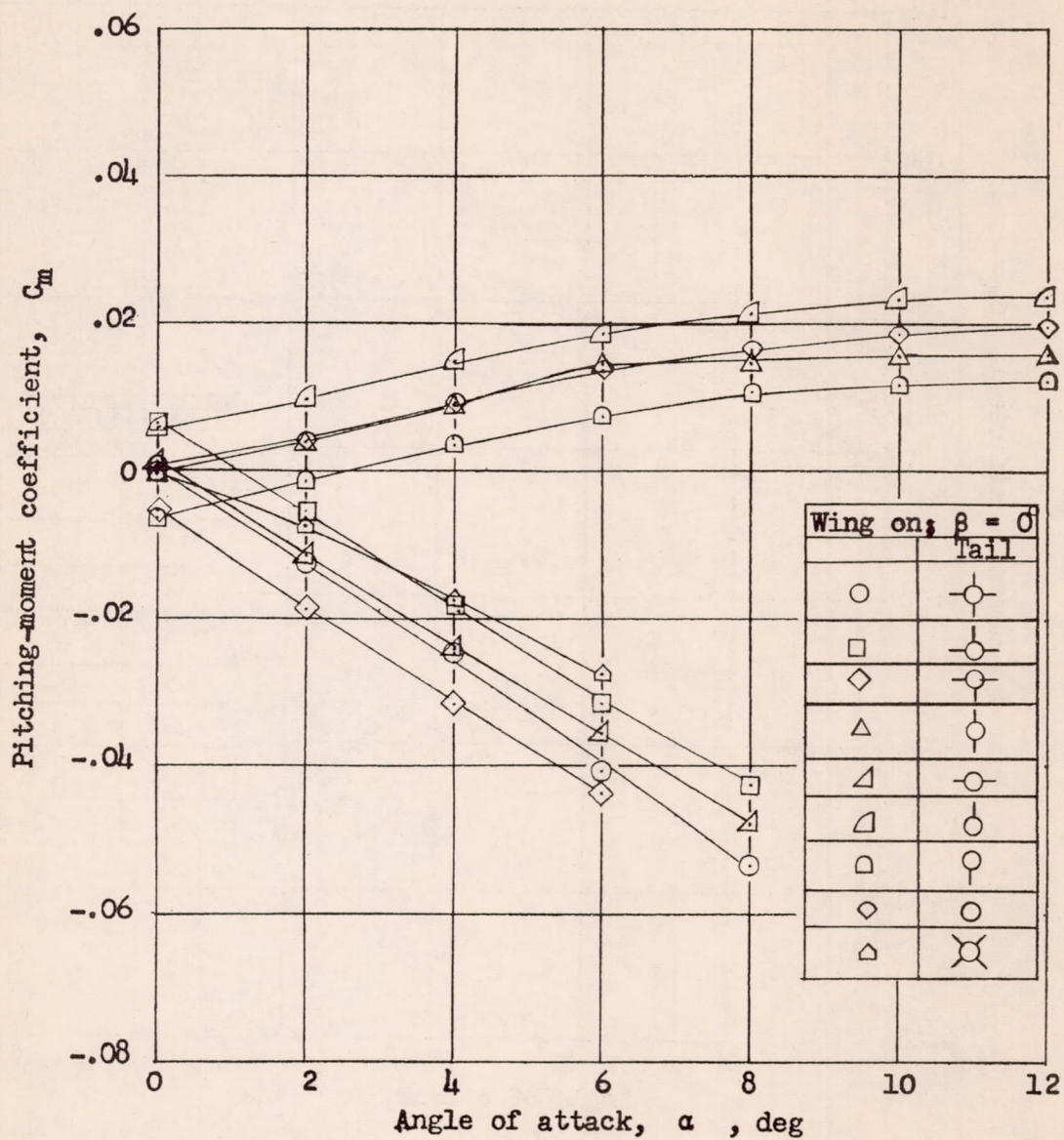
(h) Tail off.

Figure 7.- Continued.



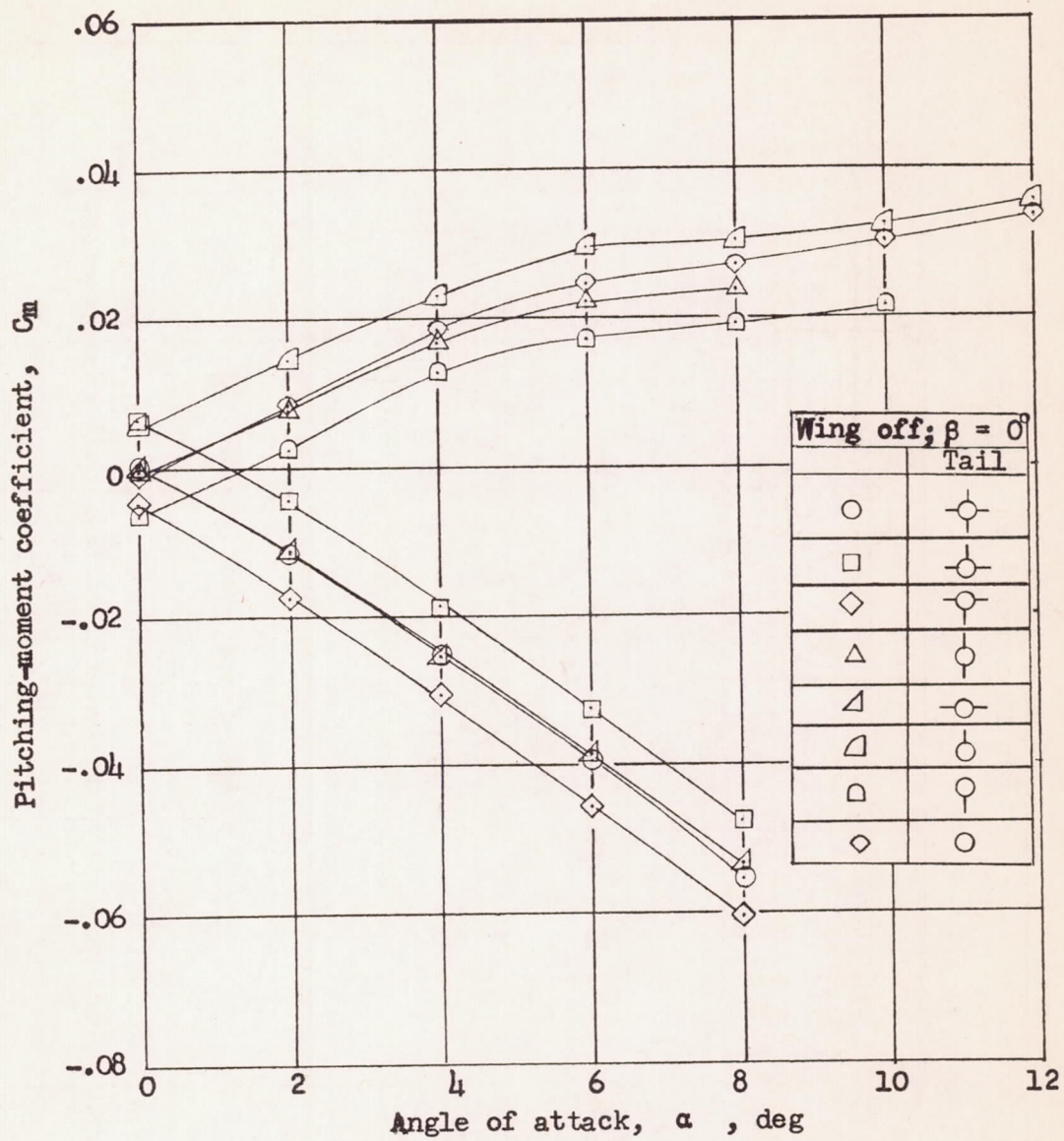
(i) X-tail.

Figure 7.- Concluded.



(a) Body-wing-tail combination.

Figure 8.- Comparison of the effect of various tail arrangements on pitching-moment coefficient. $\beta = 0^\circ$.



(b) Body-tail combination.

Figure 8.- Concluded.

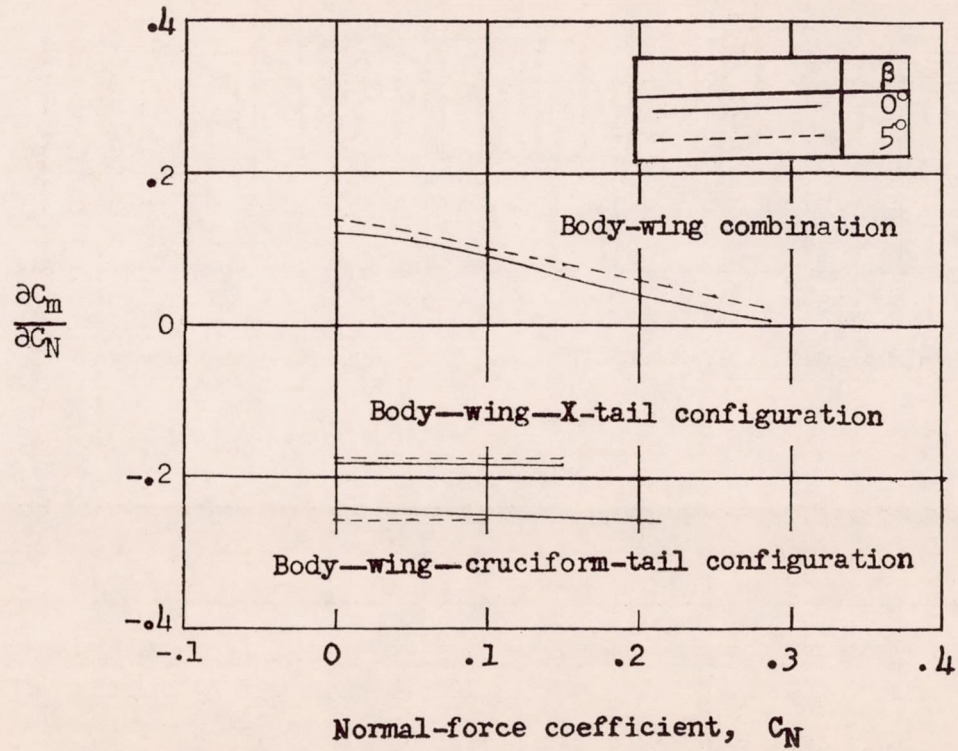
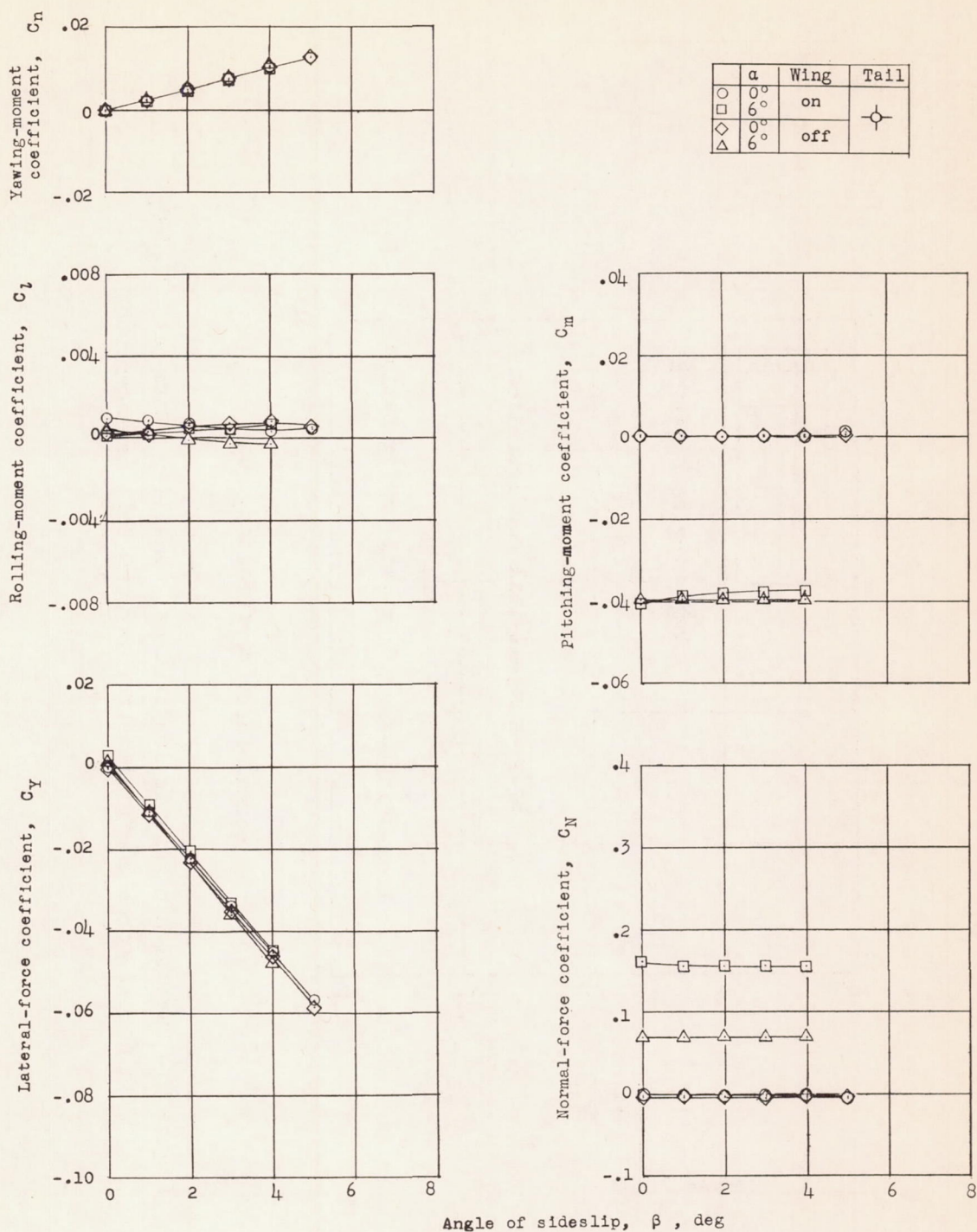
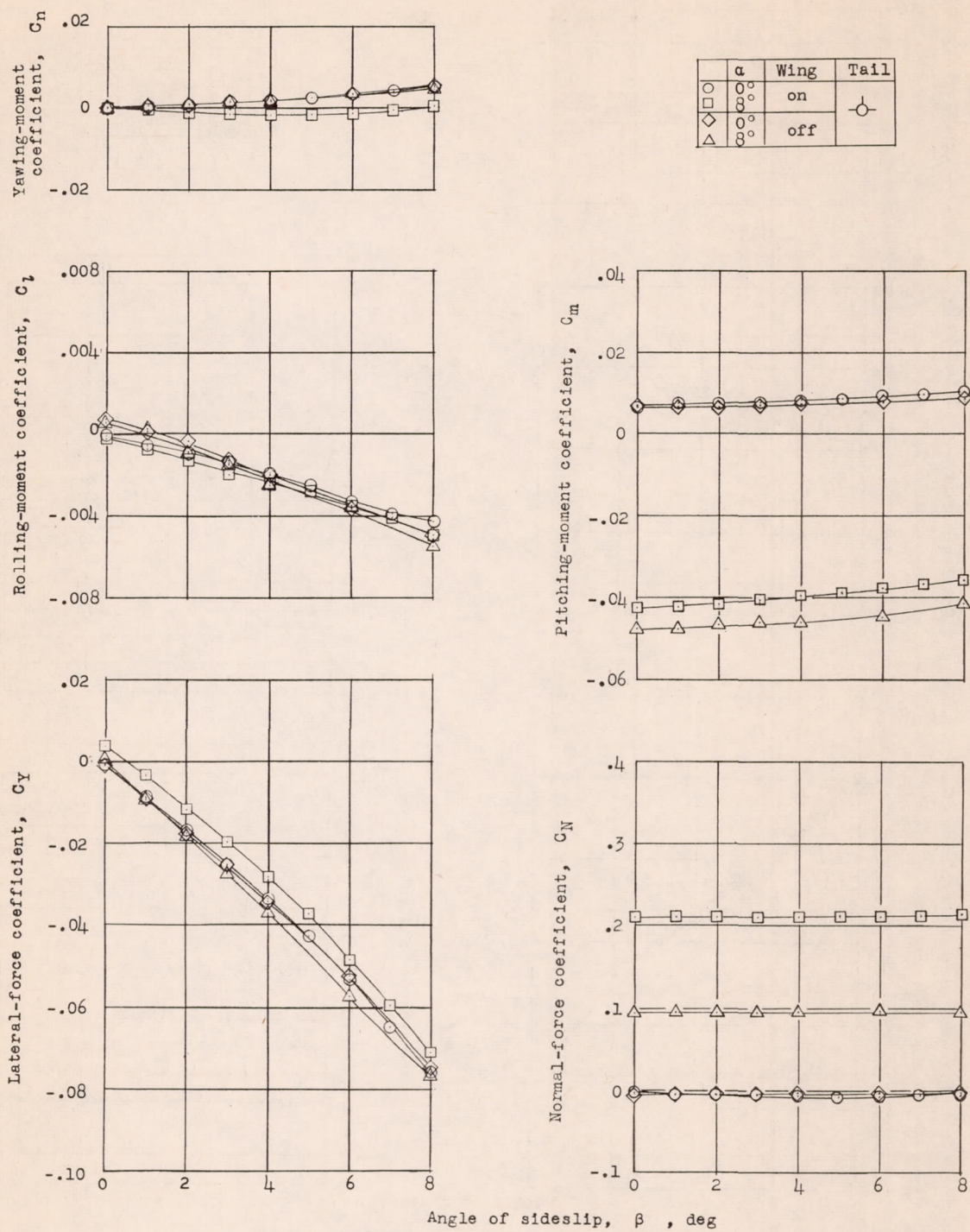


Figure 9.- Variation of static longitudinal stability parameter $\frac{\partial C_m}{\partial C_N}$ with normal-force coefficient for various tail arrangements.



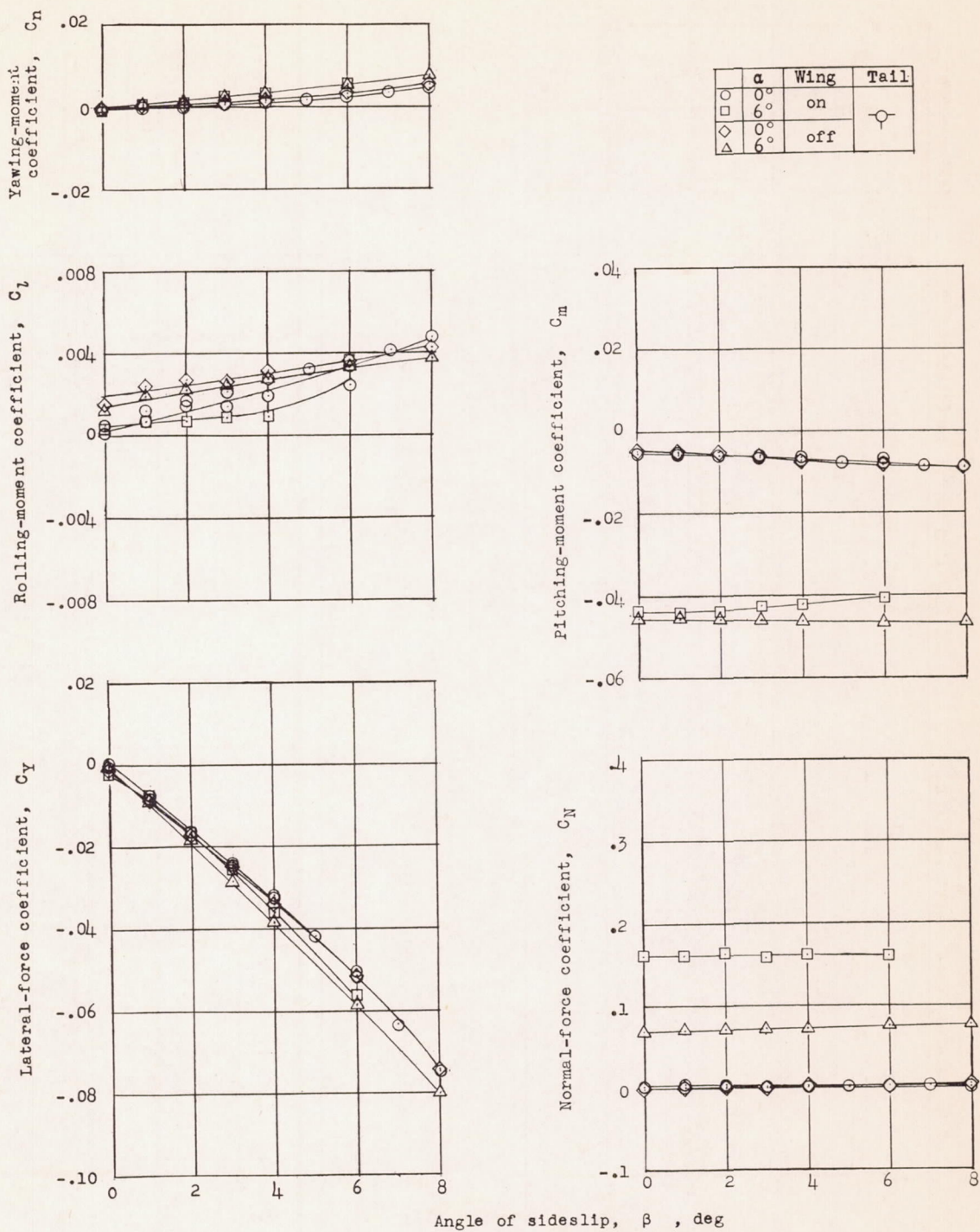
(a) Cruciform tail.

Figure 10.- Effect of the wing on the variation with sideslip angle of static lateral and longitudinal characteristics of an airplane configuration with various tail arrangements.



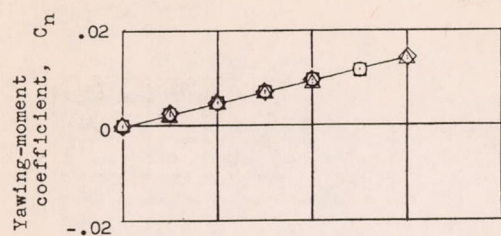
(b) Horizontal tail and upper vertical tail.

Figure 10.- Continued.

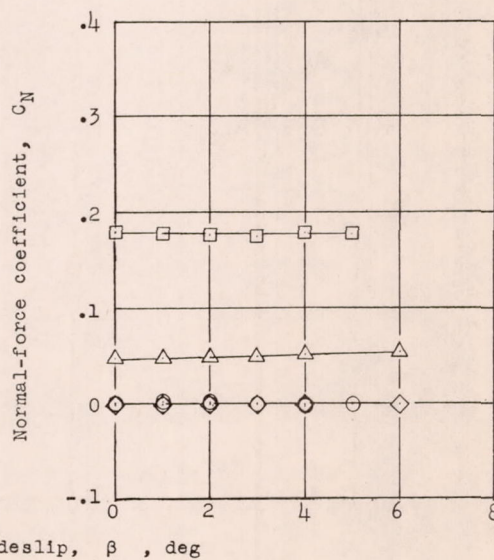
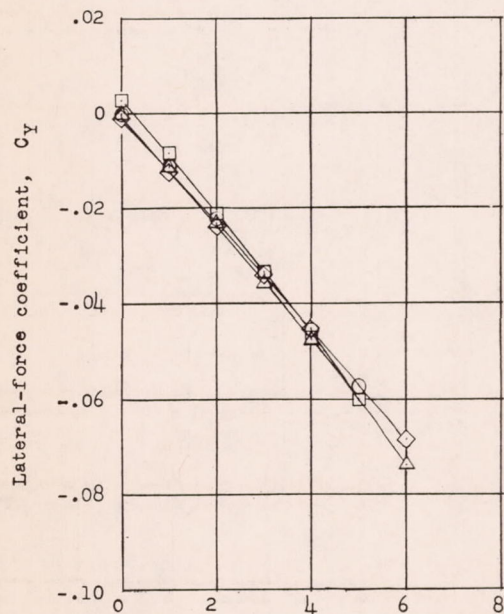
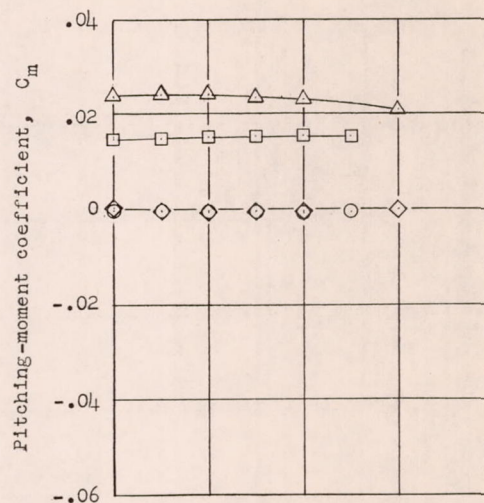
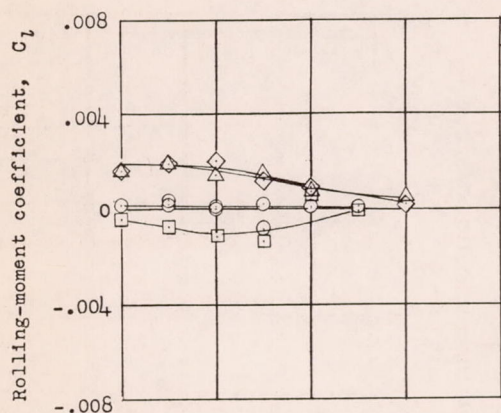


(c) Horizontal tail and lower vertical tail.

Figure 10.- Continued.

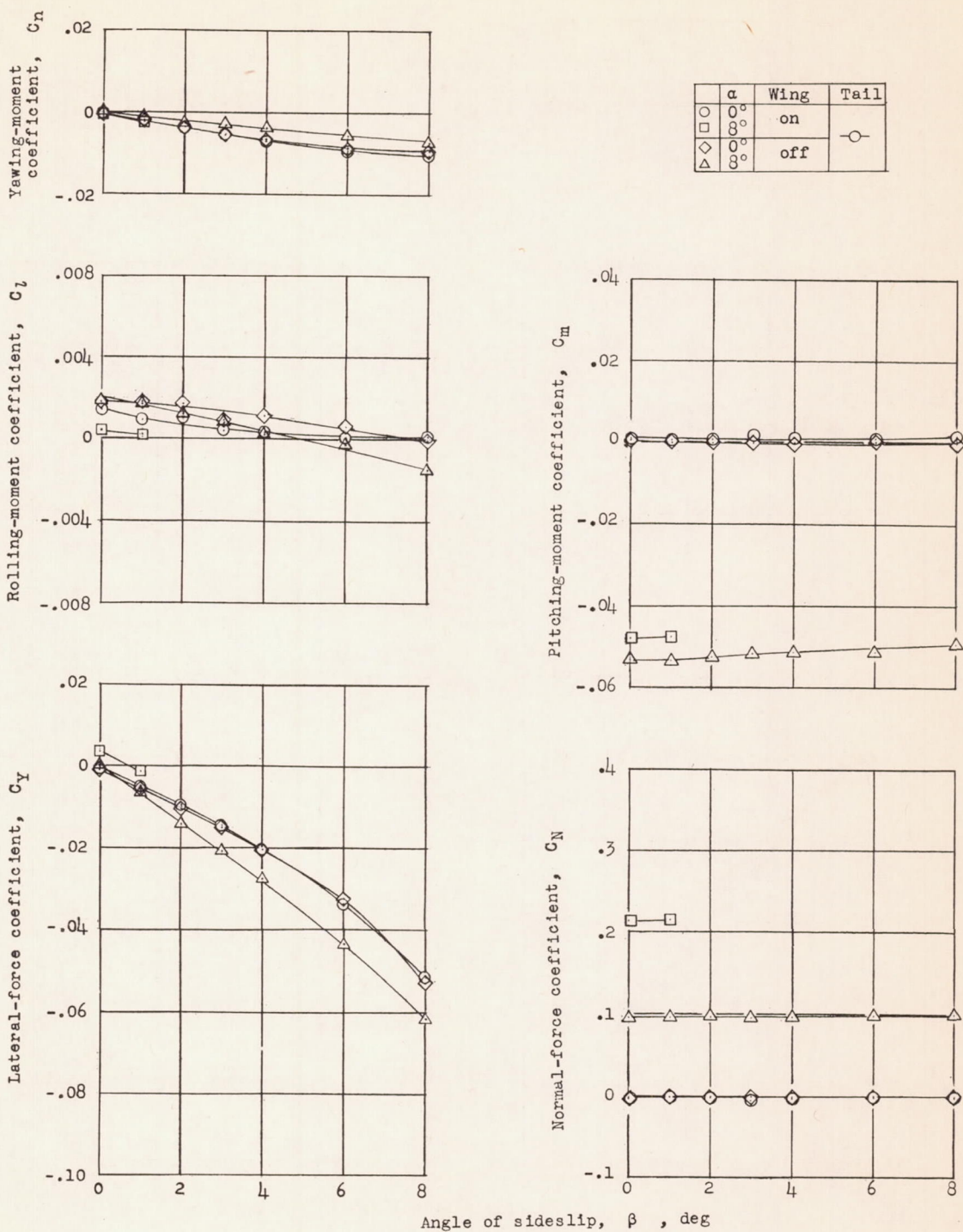


	α	Wing	Tail
○	0%	on	○
□	2%	on	○
◇	4%	on	○
△	6%	on	○
○	0%	off	○
□	2%	off	○
◇	4%	off	○
△	6%	off	○

Angle of sideslip, β , deg

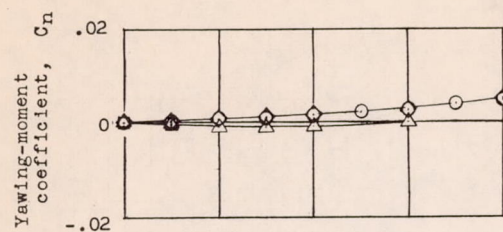
(d) Vertical tails.

Figure 10.- Continued.

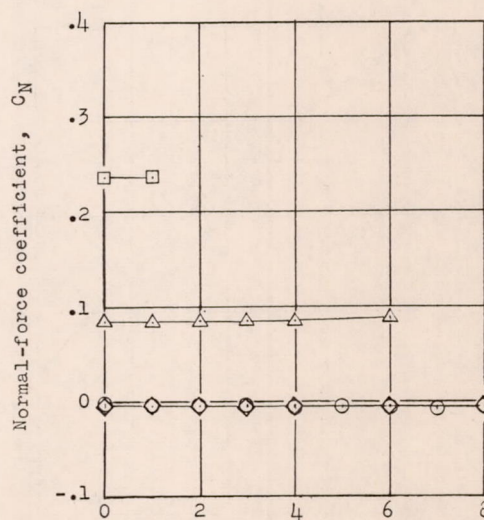
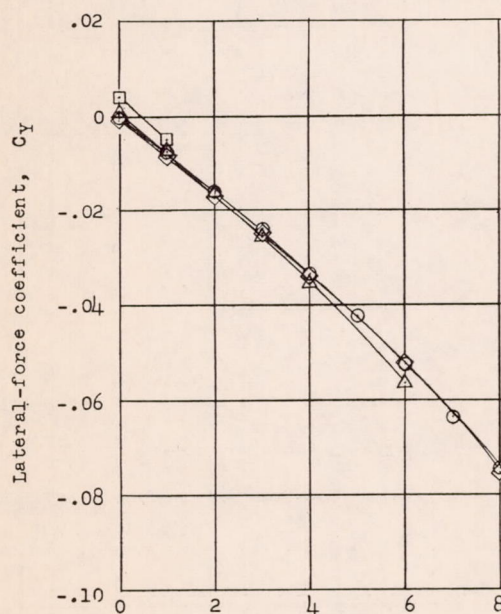
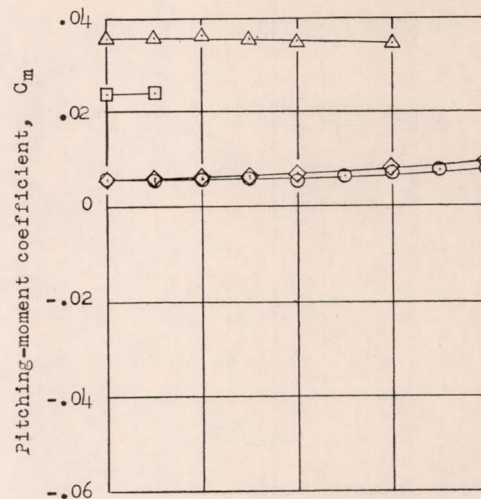
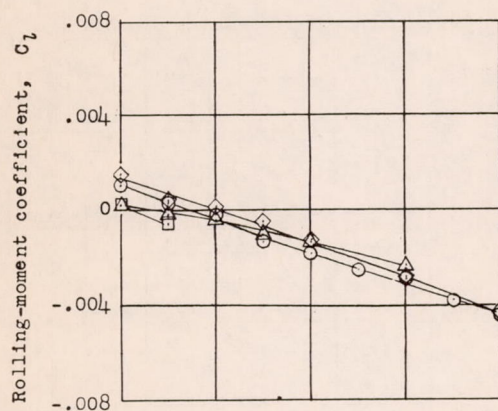


(e) Horizontal tail.

Figure 10.- Continued.



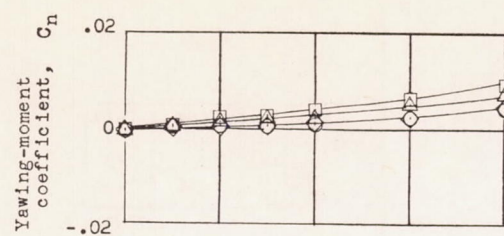
	α	Wing	Tail
○	0°	on	○
□	12°	on	○
◇	0°	off	○
△	12°	off	○



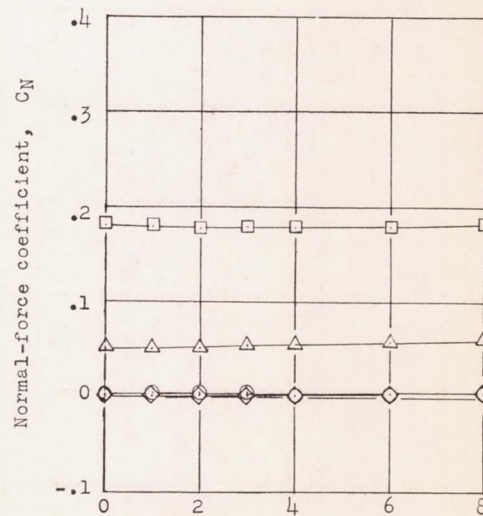
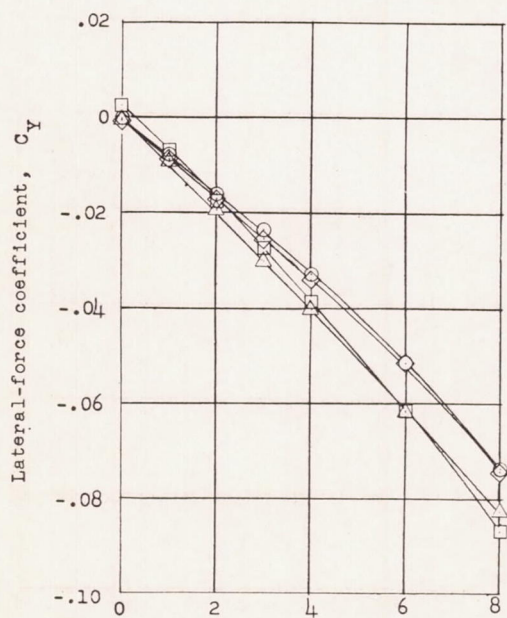
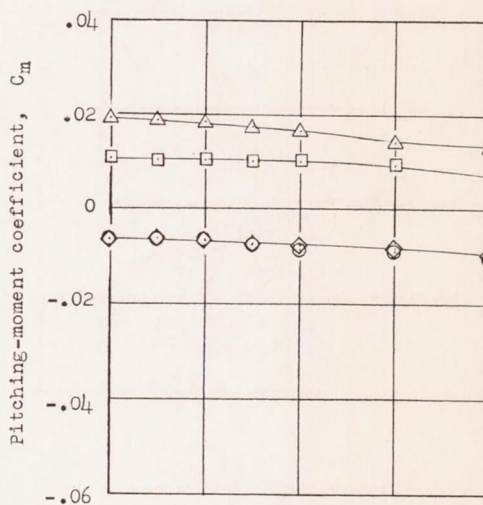
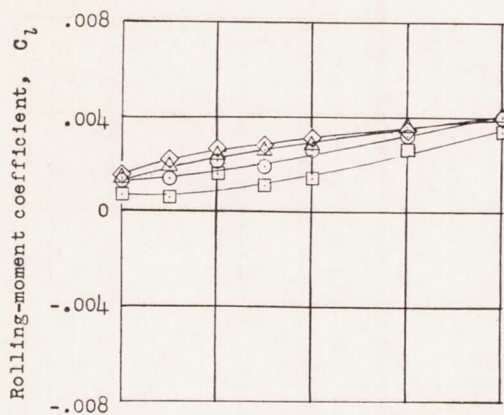
Angle of sideslip, β , deg

(f) Upper vertical tail.

Figure 10.- Continued.



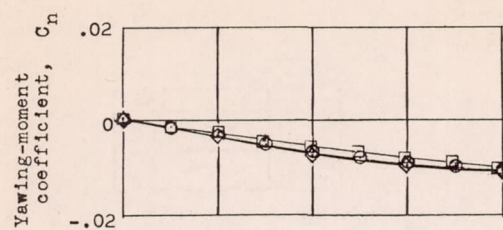
	α	Wing	Tail
○	0°	on	○
□	2°	on	○
◇	4°	on	○
△	6°	on	○
○	0°	off	○
□	2°	off	○
◇	4°	off	○
△	6°	off	○



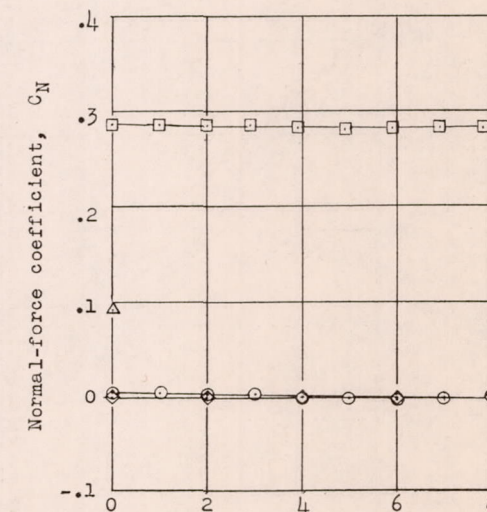
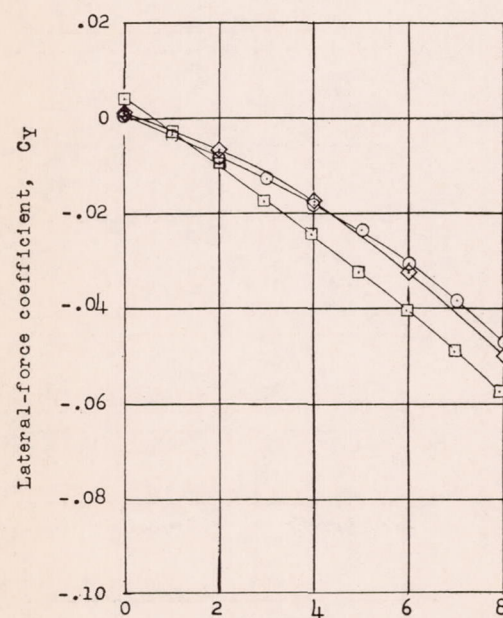
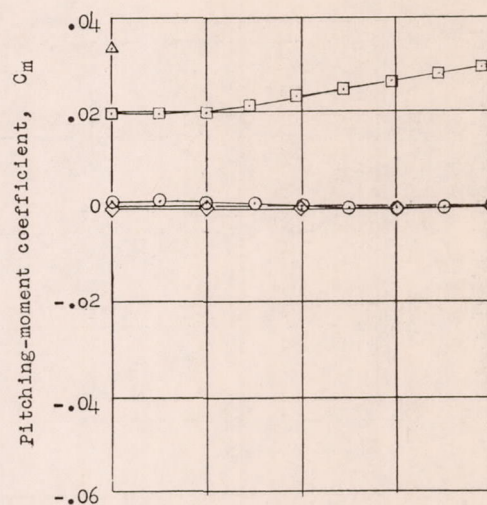
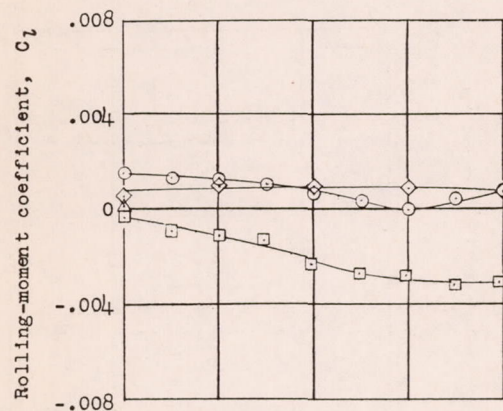
Angle of sideslip, β , deg

(g) Lower vertical tail.

Figure 10.- Continued.



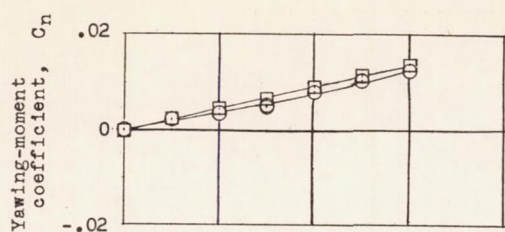
	α	Wing	Tail
○	0°	on	○
□	12°	on	
◇	0°	off	
△	12°	off	



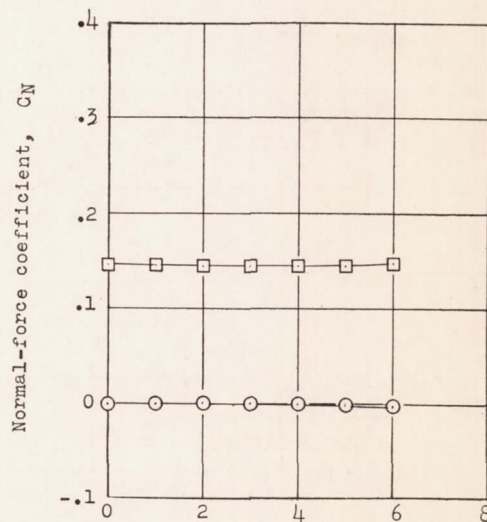
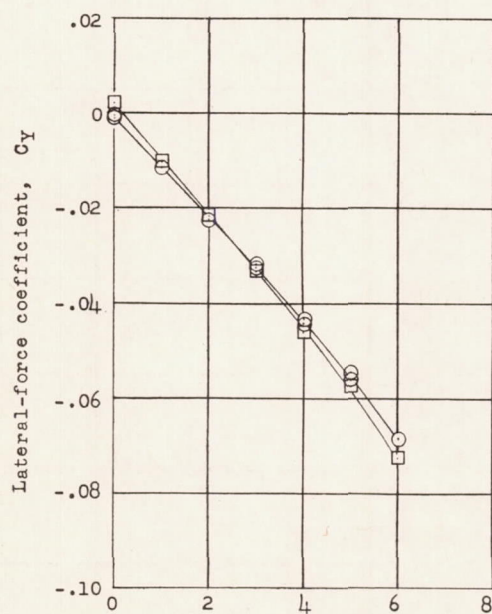
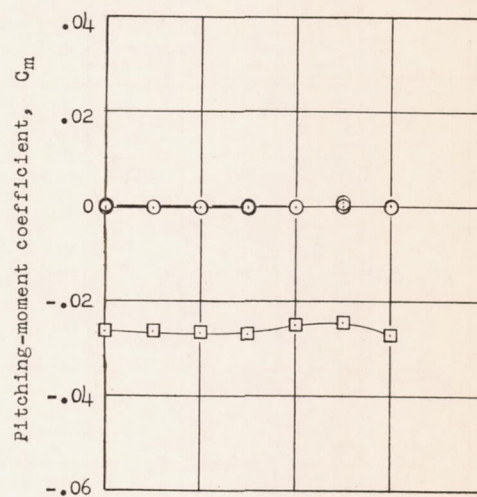
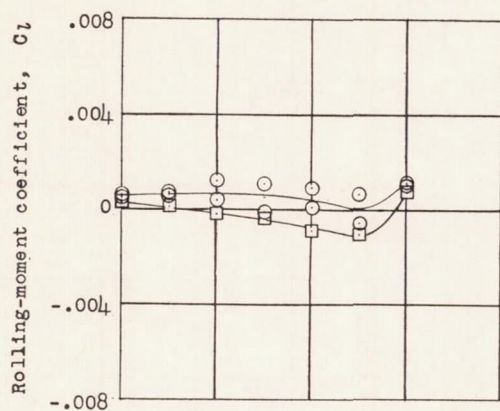
Angle of sideslip, β , deg

(h) Tail off.

Figure 10.- Continued.



	α	Wing	Tail
○	6.0°	on	×
□	6.0°	on	×



Angle of sideslip, β , deg

(i) X-tail.

Figure 10.- Concluded.

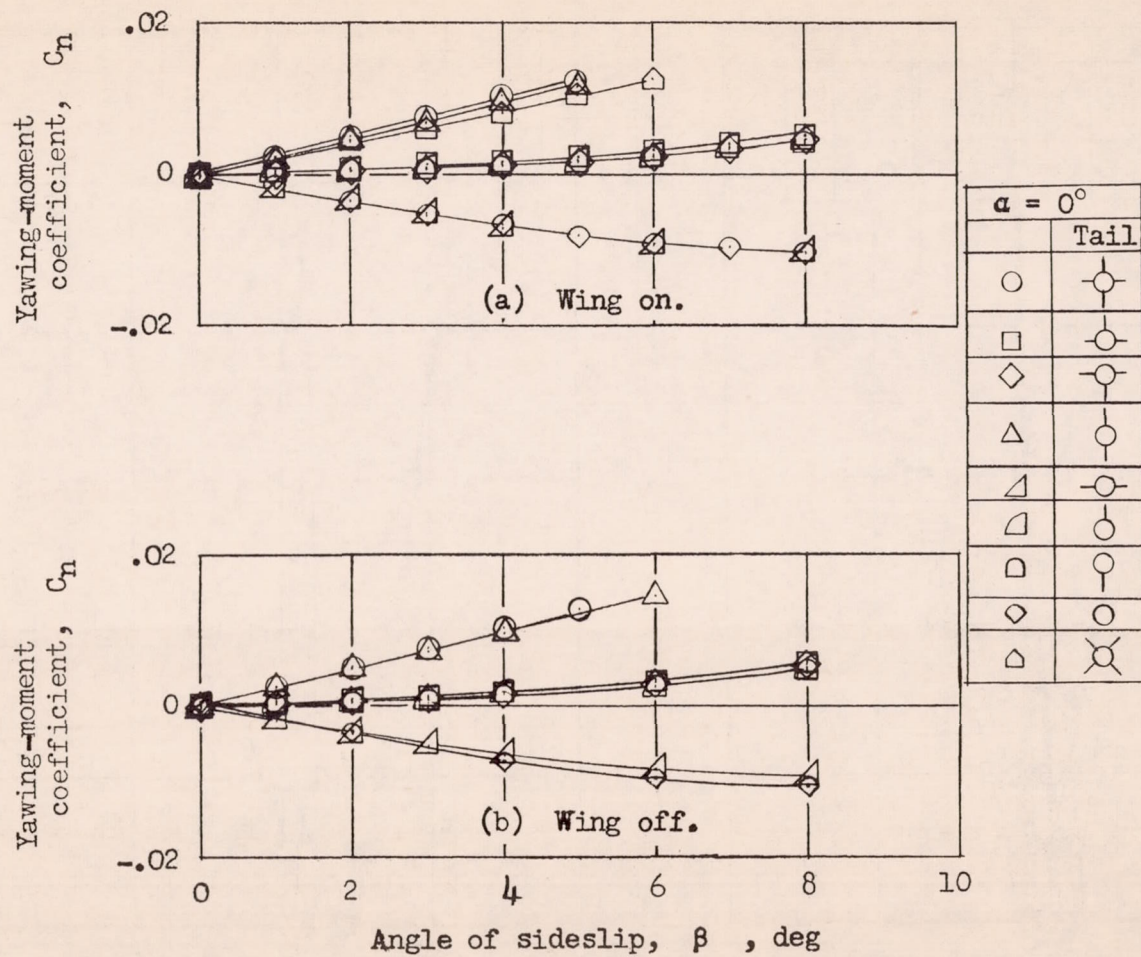


Figure 11.- Comparison of the variation of yawing-moment coefficient with sideslip angle for various tail configurations. $\alpha = 0^\circ$.

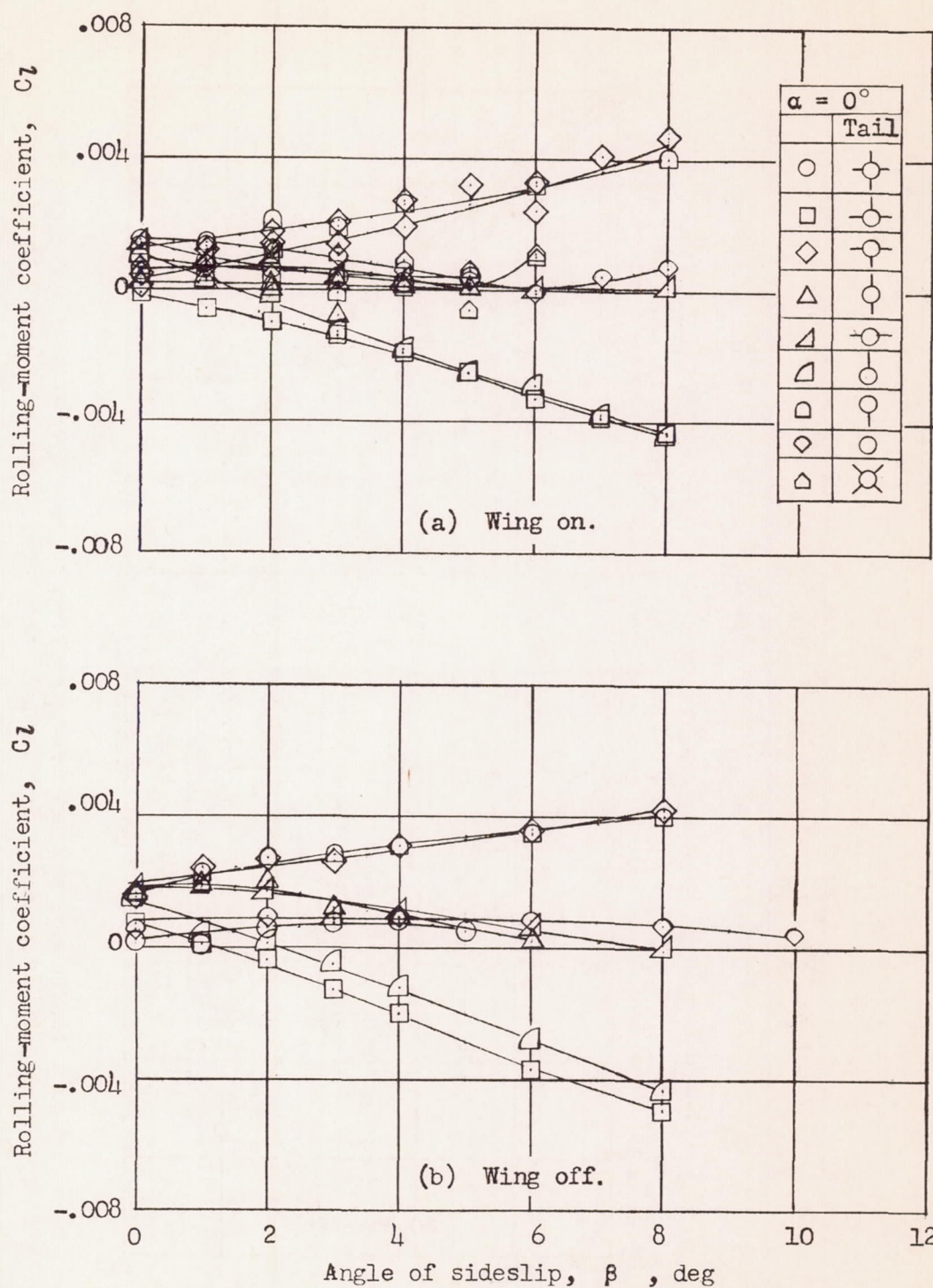


Figure 12.- Comparison of the variation of rolling-moment coefficient with sideslip angle for various tail configurations. $\alpha = 0^\circ$.

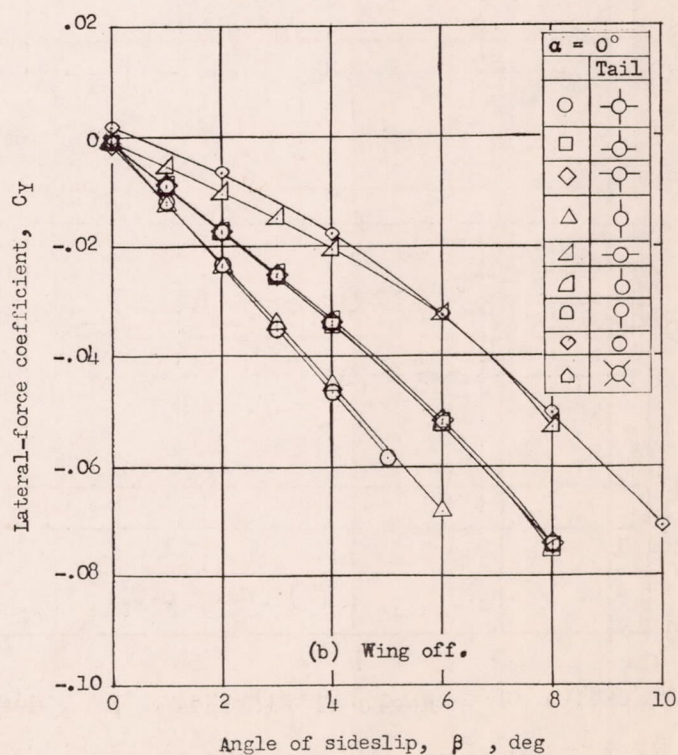
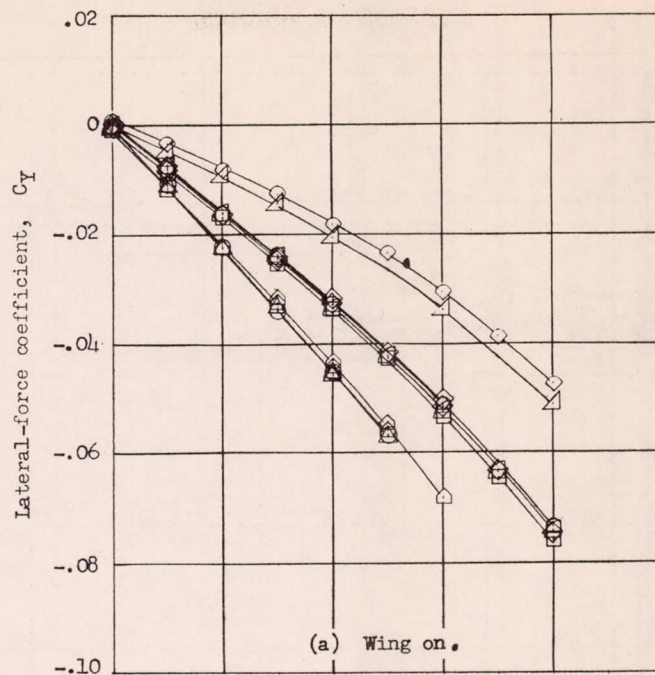


Figure 13.- Comparison of the variation of lateral-force coefficient with sideslip angle for various tail configurations. $\alpha = 0^\circ$.

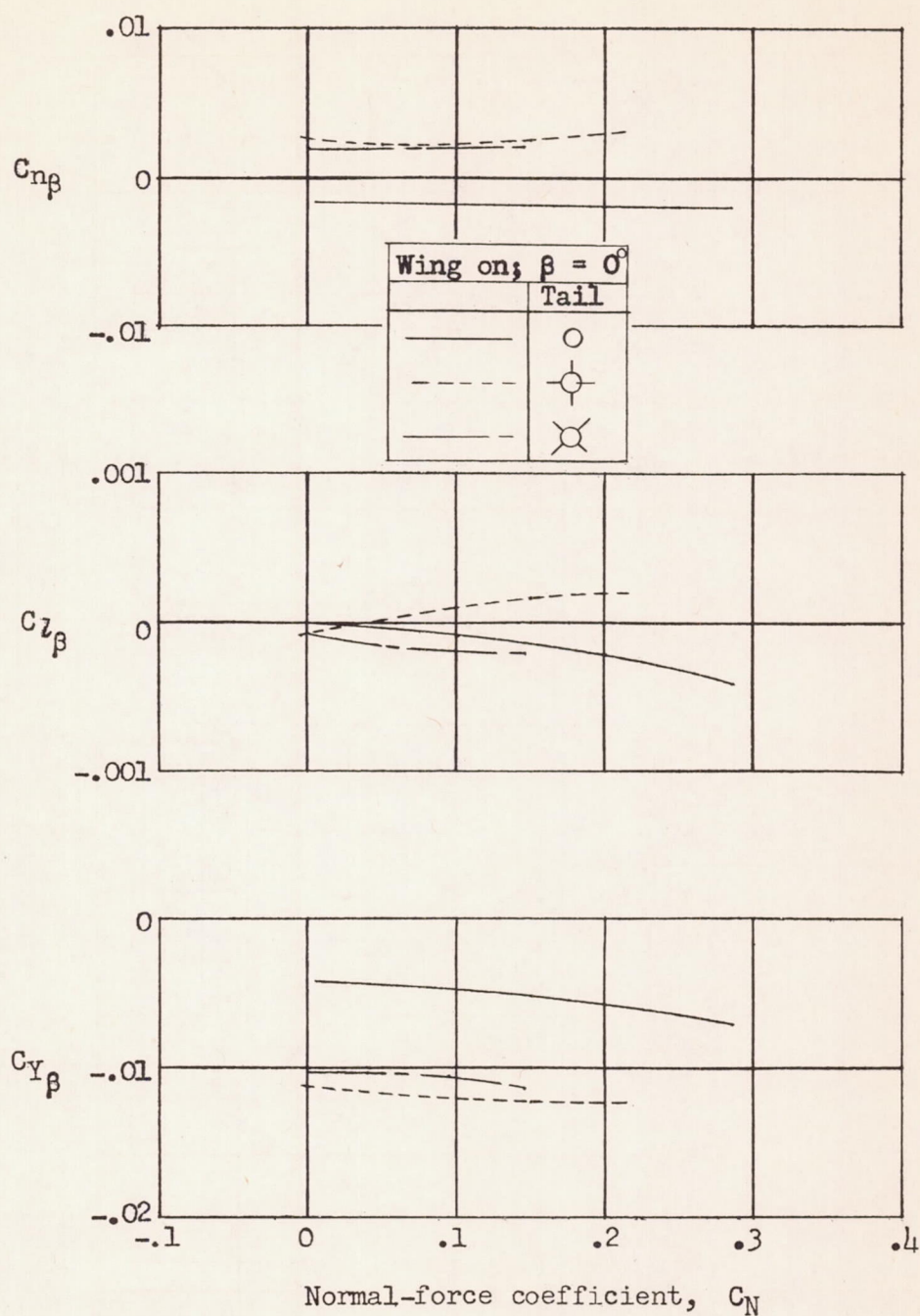


Figure 14.- Variation of static lateral stability derivatives $C_{n\beta}$, $C_{l\beta}$, and $C_{y\beta}$ with normal-force coefficient for various wing-tail arrangements. $\beta = 0^\circ$.

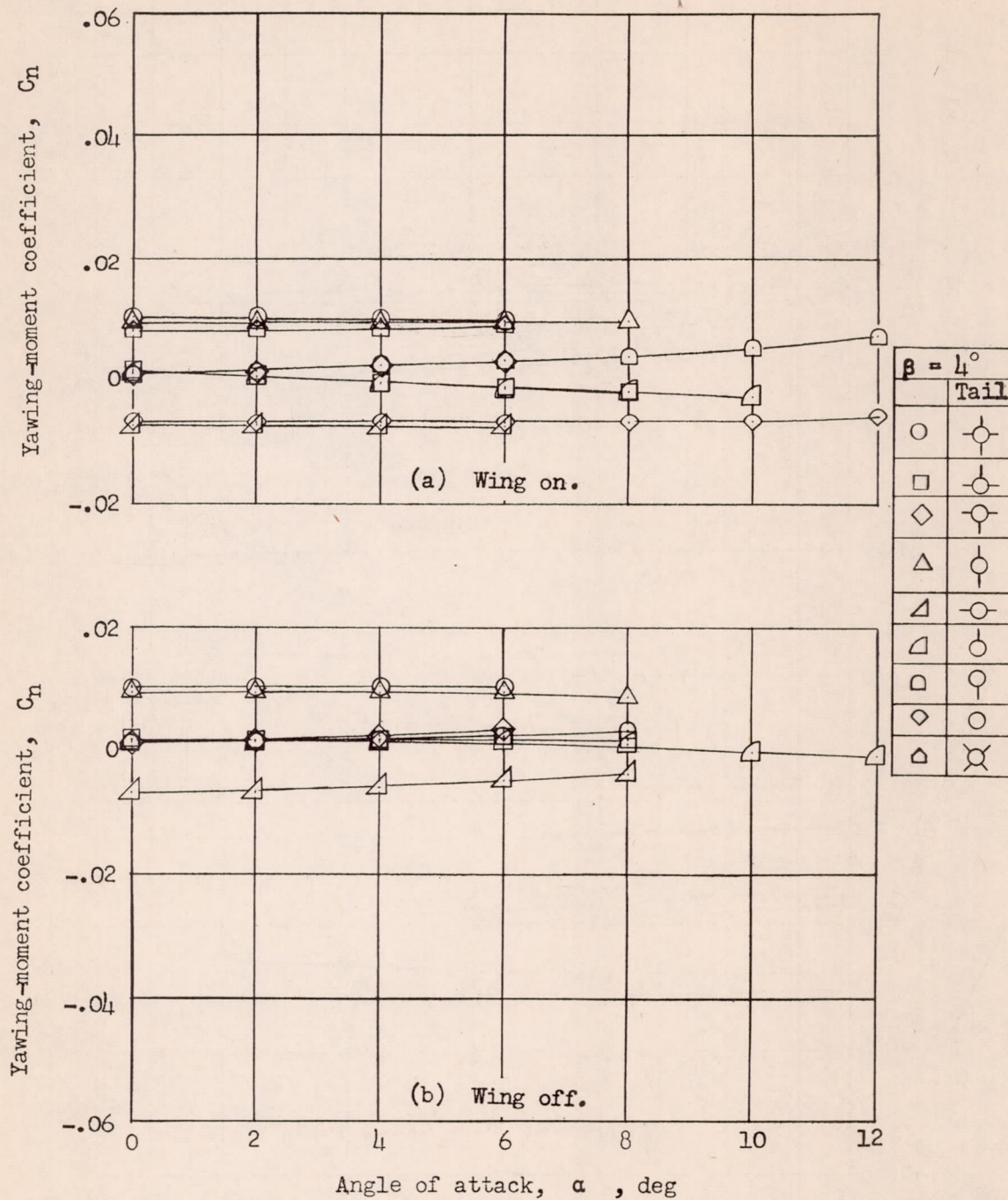


Figure 15.- Comparison of the variation of yawing-moment coefficient with angle of attack for various tail configurations. $\beta = 4^\circ$.

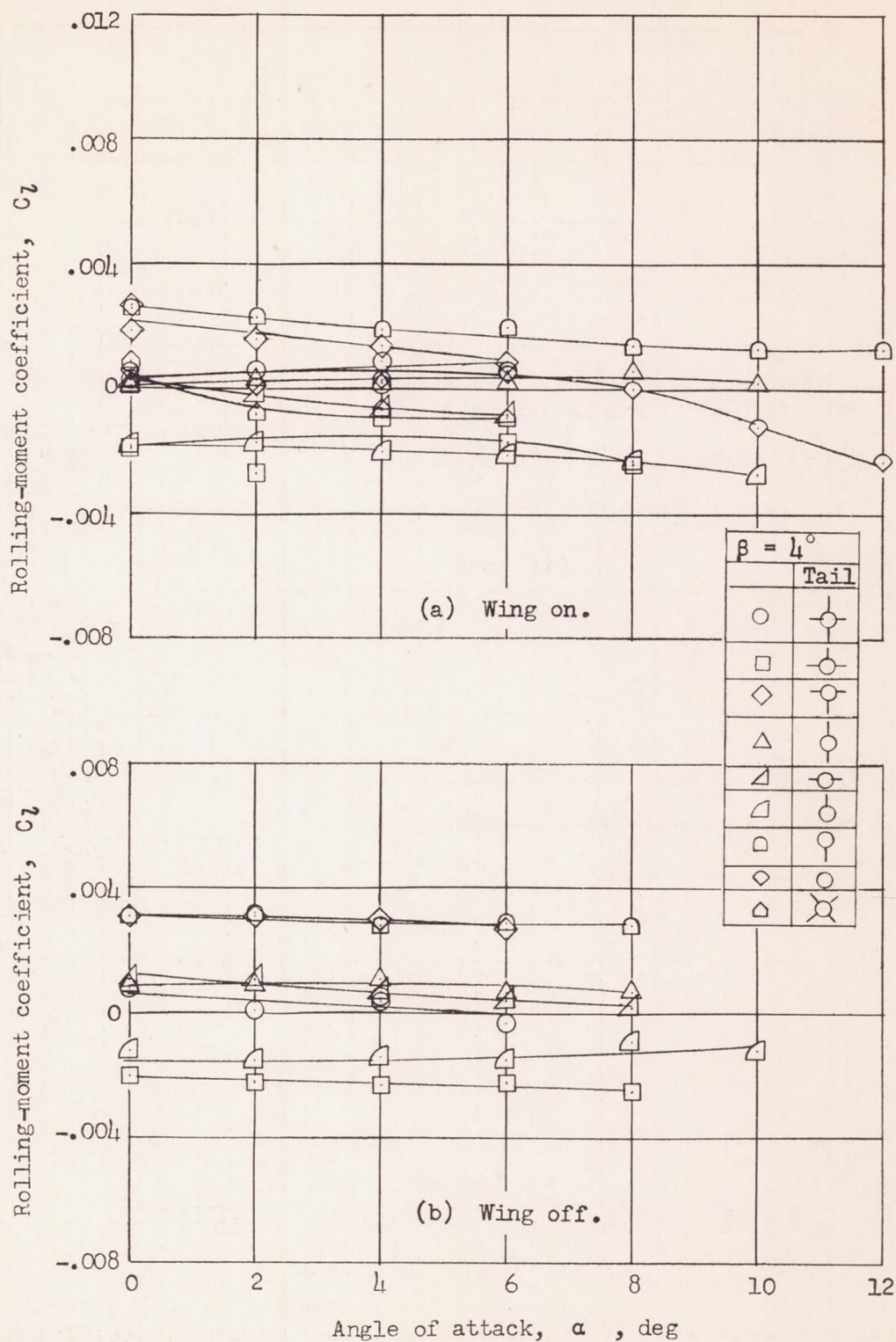


Figure 16.- Comparison of the variation of rolling-moment coefficient with angle of attack for various tail configurations. $\beta = 4^\circ$.

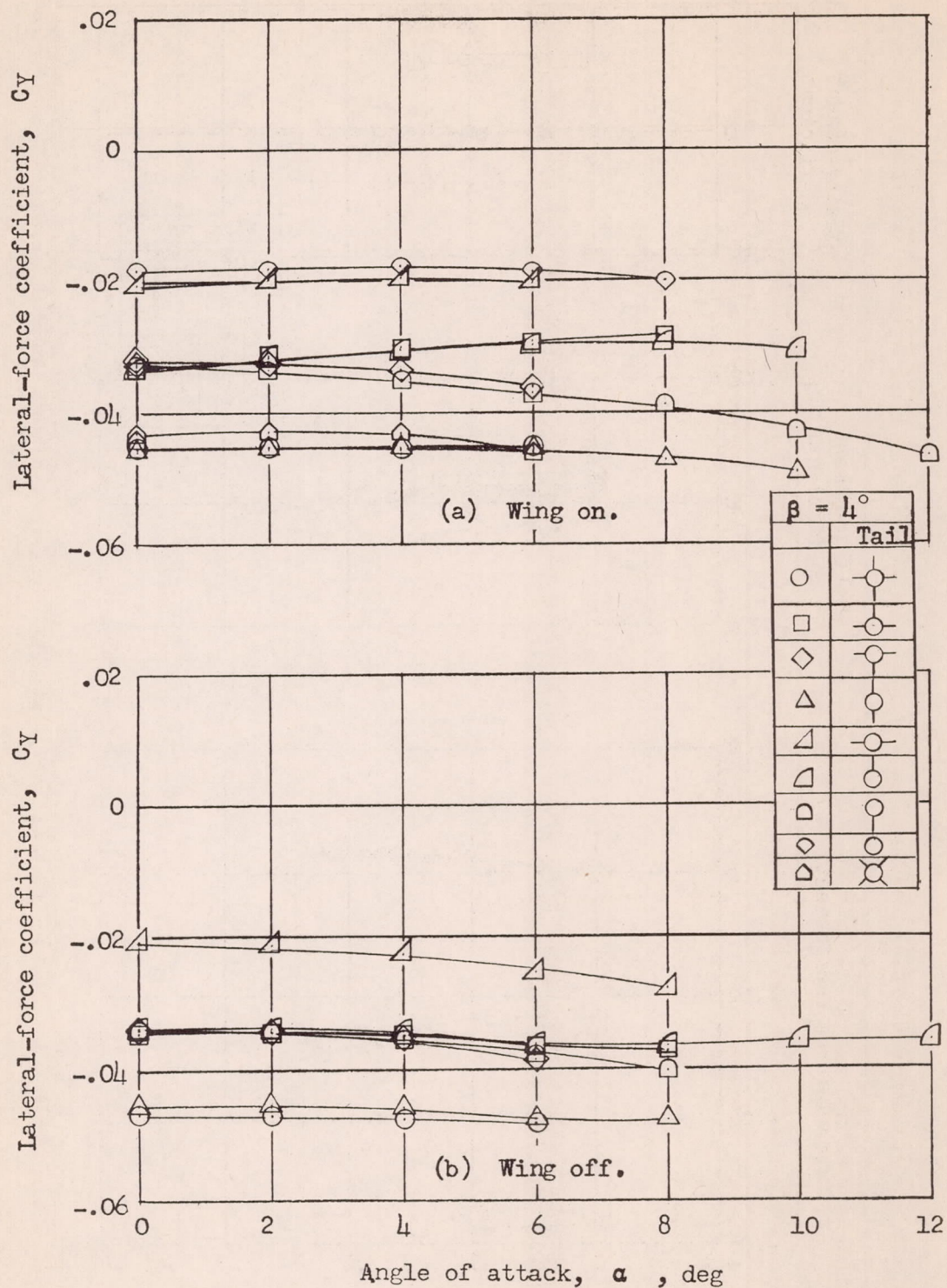


Figure 17.- Comparison of the variation of lateral-force coefficient with angle of attack for various tail configurations. $\beta = 4^\circ$.

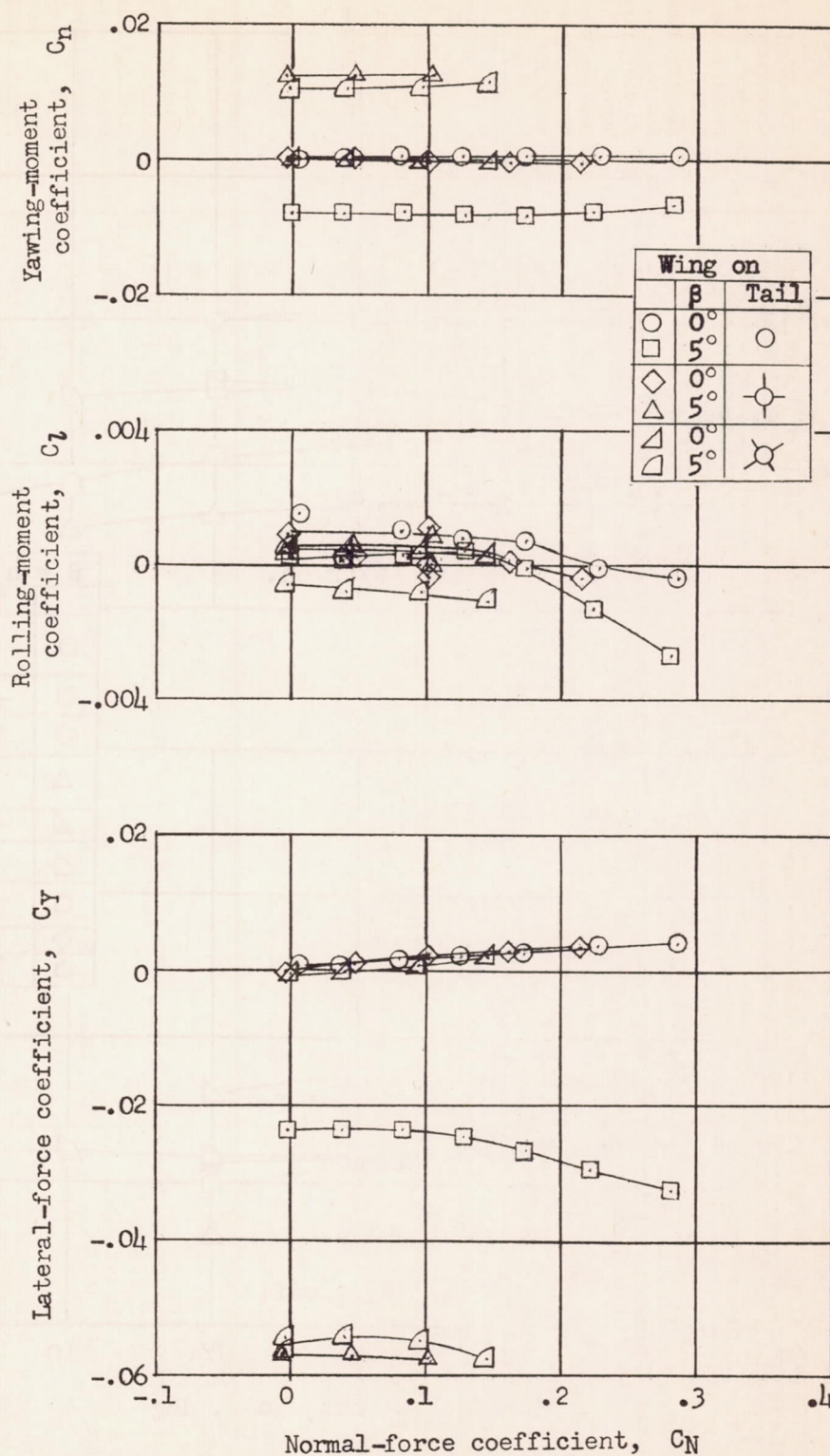
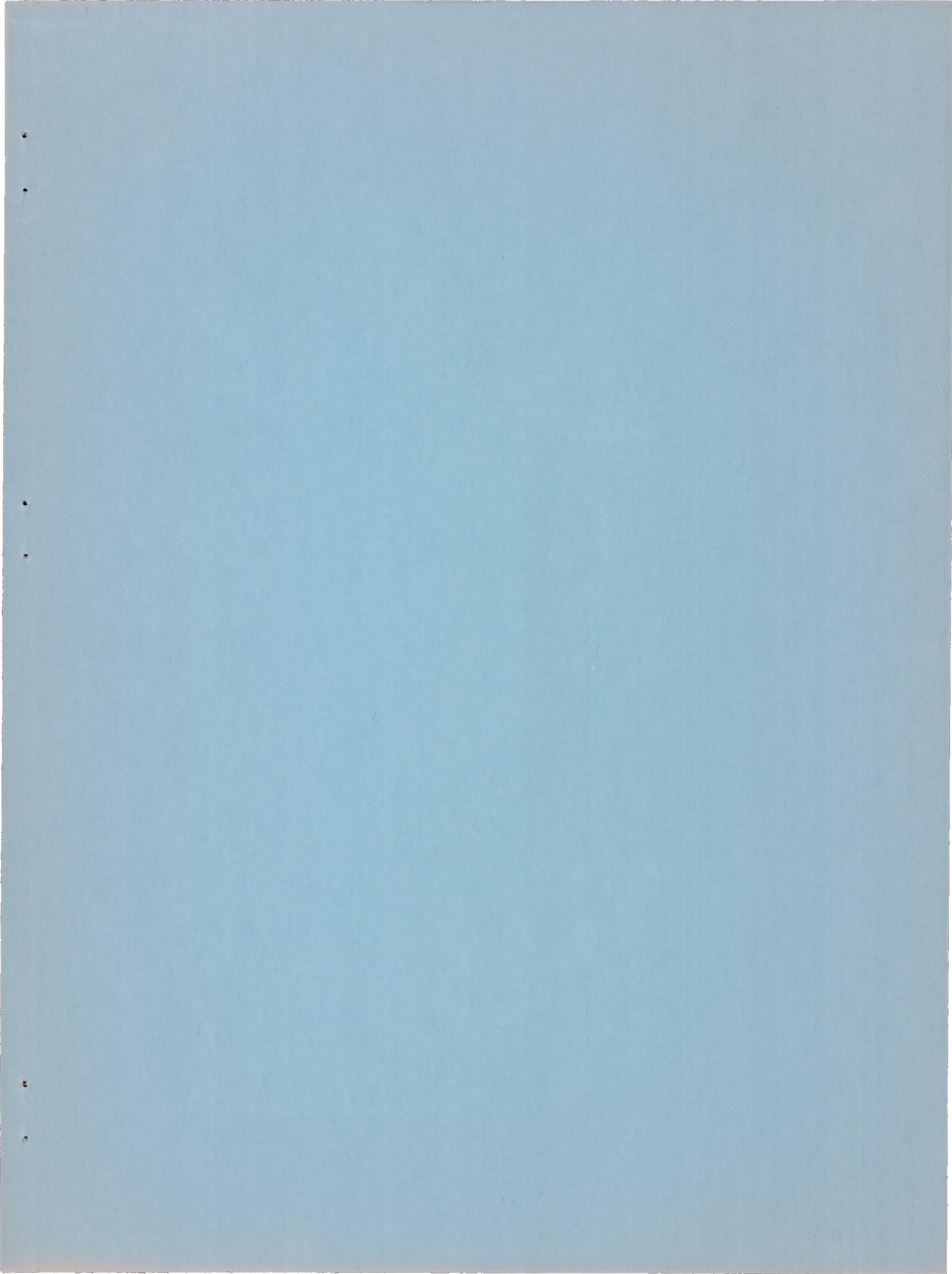


Figure 18.- Variation of static lateral characteristics with normal-force coefficient for various wing-tail arrangements.



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